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Materials & Methods

THE MAGAZINE OF

MATERIALS ENGINEERING

DEVOTED TO THE MATERIALS PROBLEMS OF PRODUCT DESIGN AND MANUFACTURE

Plastic Exposition Preview

A Critical Look at Salt Spray Tests

Copper-Clad Aluminum Conserves Copper

Inert-Gas Metal Arc Welding of Carbon Steels

Plastic Shapes Produced by Automatic Blow Molding

New Protective Treatment for Aluminum

Machinability of Thin Gray Iron Castings

New Electrodes Power for Aluminum

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52

LEADERSHIP can't stand still

this time it advances on spectral waves

Way back in 1914, before the term "quality control" had been invented, The American Brass Company installed in its laboratories the *first* spectrograph used by industry anywhere in the world. Today, this Company, first in its field, has introduced the latest word in rapid analytical procedures, the . . .

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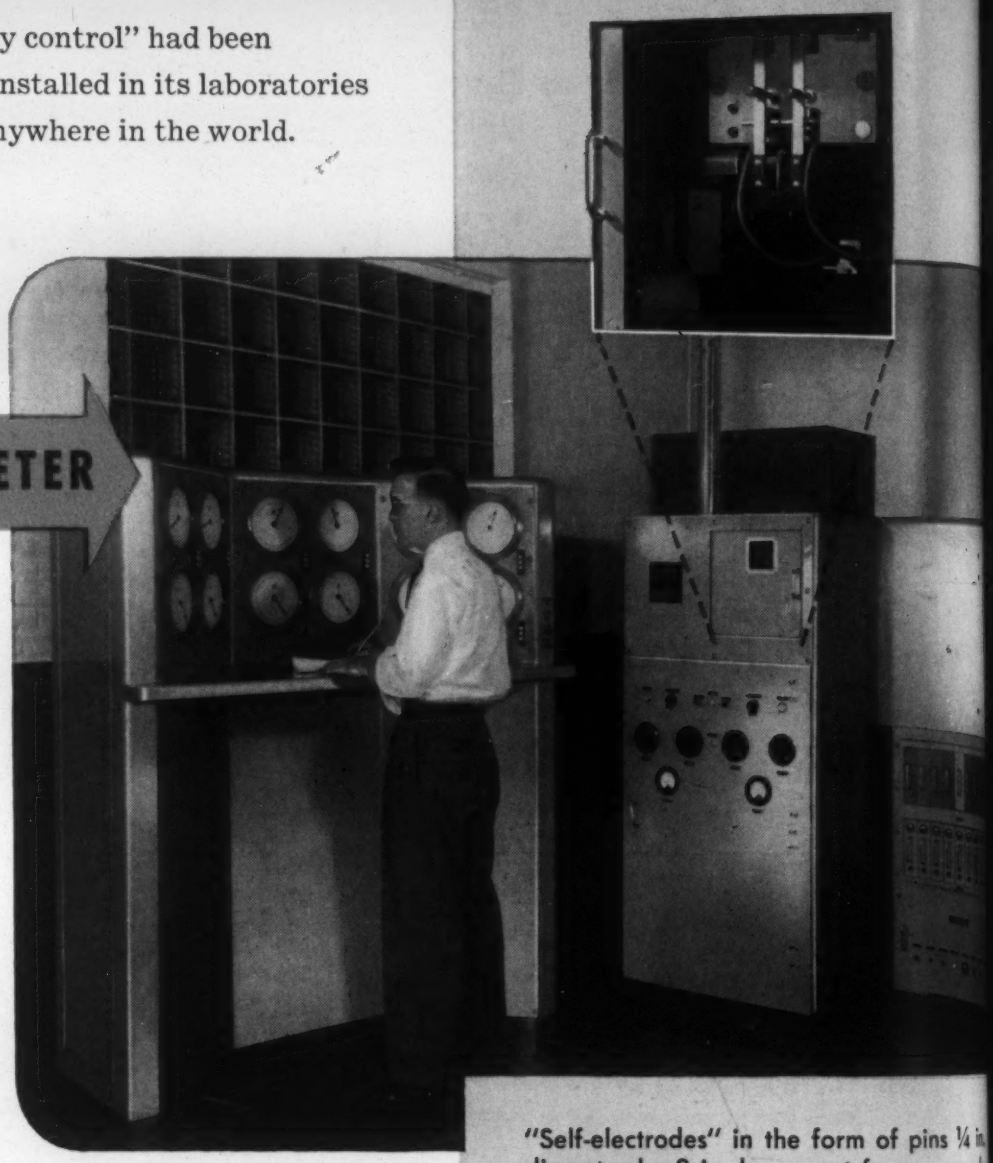

What it does

In five minutes by spectrochemical methods this instrument completes an analysis that would take several hours by spectrographic procedures and several days by the traditional methods of chemical analysis. Now an electric furnace charge of molten metal can be analyzed *before* it is poured.

What it means

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5287

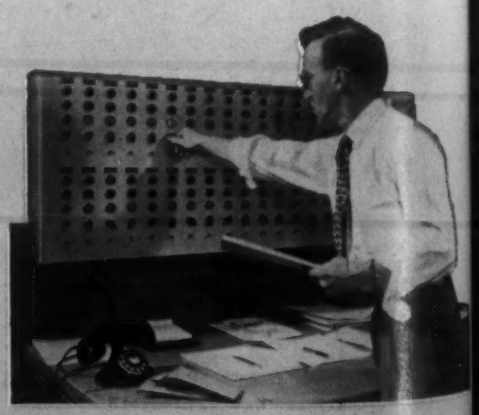
ANACONDA

sets the pace in quality control of

COPPER and COPPER ALLOYS

"Self-electrodes" in the form of pins ¼ in. diameter by 2 in. long, cast from a sample of the melt to be analyzed, are accurately spaced in the electrode holders of the Baird Associates—DOW Direct Reading Spectrometer (top illustration). A button is pressed—and a 25,000-volt spark bridges the gap. Then...

Light from the spark falls on a grating and is reflected, in a separate spectrum line for each element, onto photomultiplier tubes. Seconds later, accurate, direct dial readings indicate the amount of alloying elements present and the amount of impurities, such as iron, nickel, manganese, aluminum, silicon, lead, arsenic, phosphorus and antimony.



With the analysis of the melt known to be right, a "go-ahead" is flashed to the casting shop and the metal is poured.

Materials & Methods®

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"That's it! I'll bet that's the answer to my coating problem"

"Ted Hubbard, what *are* you talking about?" asked his wife.

"That wax paper you're tearing . . . that may be the answer to the thing that's been giving the can manufacturers all the trouble."

Ted, an Inland mill representative, had been working for some time on a very peculiar problem in the plant of a large can maker and Inland tin plate customer. In lacquering tin plate for can ends, this customer's sheets had been coming through with "eye holes" (pin-head-size spots where lacquer failed to coat). Neither Ted, nor anyone else, had been able to learn *why*.

Ted, idly watching his wife tear wax paper from a roll, remembered: *Wrapping tin plate packages in wax paper was standard practice for many steel producers, and paraffin, a mineral oil derivative, would not mix with lacquer.*

Ted had a hunch.

Next day, the problem was solved! Ted proved that when the tin plate was removed from the wax paper wrapper, microscopic wax particles adhered to the edges of the sheets. During the lacquering process, these particles were drawn up from the edges and across the sheets by suction from the lifting device . . . were picked up by the roller coaters . . . and wherever a particle lodged, lacquer failed to coat that spot on the sheet. This was the cause of the eye holes.

Tin plate producers switched to a different type of paper wrapping with the result: no more eye holes! INLAND STEEL COMPANY, 38 South Dearborn Street, Chicago 3, Illinois.

Names used are fictitious

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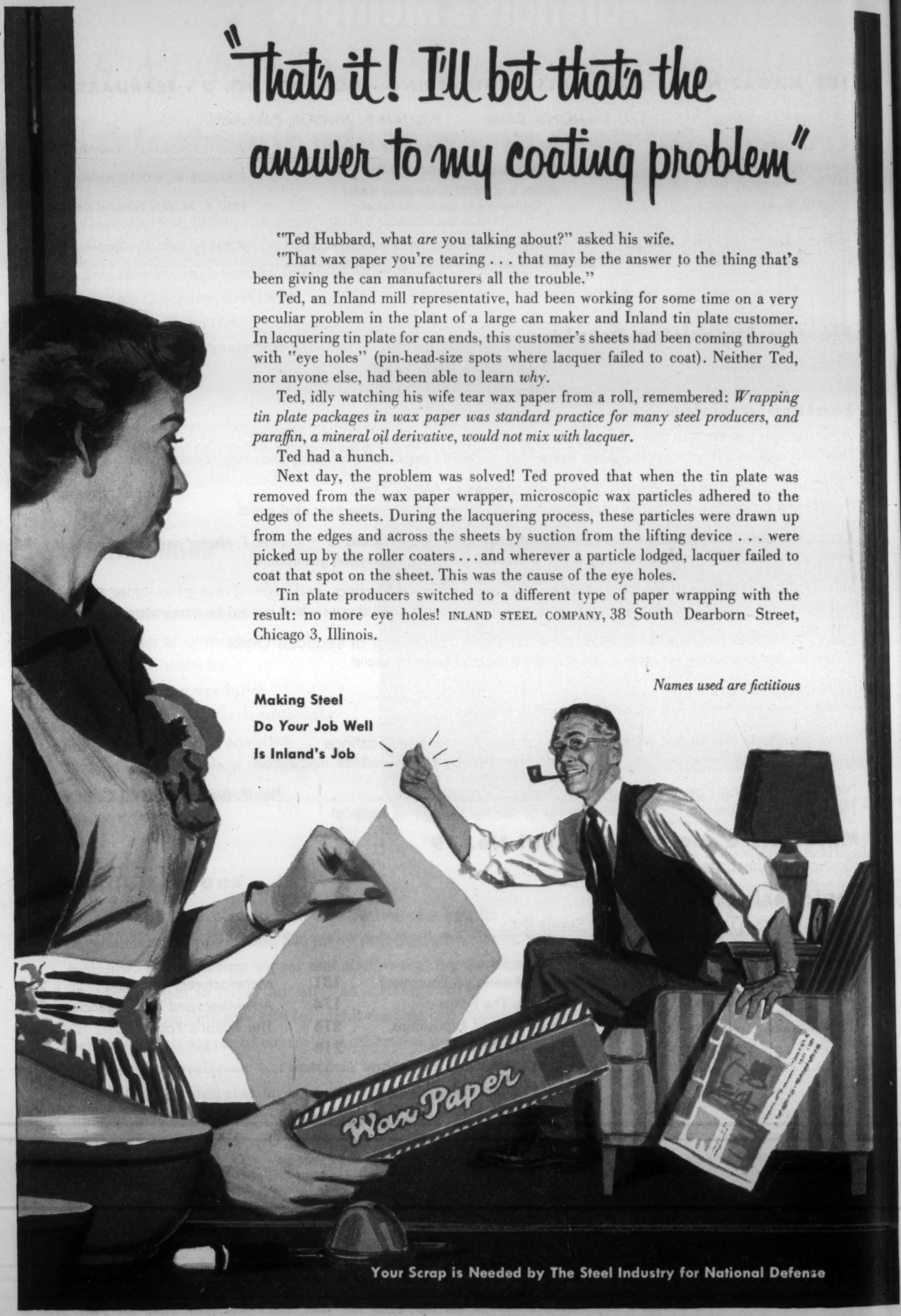
Do *Your* Job Well
Is Inland's Job



Your Scrap is Needed by The Steel Industry for National Defense

The Materials Outlook

During the last year, Hotpoint has made about 3,000 engineering changes because of materials shortages. The switches have not impaired quality, but have increased costs. . . . An alloy containing 30% nickel is now being used for heating elements on electric stoves in place of the old 80% nickel alloy. The new alloy has a higher proportion of chromium and iron. . . . About half of the motors going into Hotpoint washing machines have aluminum wire winding instead of copper. . . . Clear plastic has replaced chromium-plated steel in refrigerator handles. . . . Not more than 5% of these changes will be permanent, the company estimates. One changeover that will stay is a glass reinforced plastic cover on automatic washers.

Cory Corp., another appliance manufacturer, notes the increased costs of using alternate materials. The change from nickel stainless to a chromium variety made manufacturing costs climb and increased time and scrap losses.

Monsanto notes a number of important new plastics applications. . . . Sandberg-Ferar of Chicago re-designed one household item with plastics, replacing 60% of the brass normally used. . . . Peter Muller-Munk Associates of Pittsburgh re-designed Westinghouse refrigerators with freezer and vegetable compartment doors of plastic instead of aluminum. . . . A spring scale for the postal service was changed over to plastics -- saving 3 lb of steel per scale. . . . A new automatic washer design cuts aluminum requirements from 21 to 9 lb by using plastics.

Dow Chemical reports that improved raw materials supplies and increased manufacturing facilities will permit them to expand polystyrene sales and merchandising efforts this year. New high impact and high temperature resistant polystyrenes will be coming out in greater quantities.

The Erie Railroad is now testing a plastics tie plate for railroad rails. The new plate, made of crossed glass fibers bonded with a resin (type not given), is in place on a heavily traveled track in Cleveland. . . . Advantages expected: smoother riding due to the resiliency of the plastic; greater resistance to refrigerator car brine drippings; lower handling costs due to light weight of plastic plates (one-fifth that of steel). . . . The plates are produced by the Dynakon Corp., of Cleveland.

Clad metals are coming on strong. . . . Copper-clad aluminum is being pushed for electrical applications like cable connections. . . Low car-

(Continued on page 4)

The Materials Outlook *(continued)*

bon steel clad with titanium is now being tested for the electronics industry. . . . Copper-clad magnesium is also being produced for secret applications. . . . Aluminum-clad steel has replaced a lot of nickel in electronic tubes, and is doing so good a job that producers doubt the industry will ever go back to nickel. . . . Lead-clad steel is being produced for sulfuric acid applications. Copper is also being clad with lead where copper's electrical conductivity is wanted. The electroplating industry is considering this combination for acid bath anodes.

Electroplated wire that can be drawn, formed and processed without flaking the coating is a recent development. . . . Copper- or nickel-plated wire can realize savings up to 90% of these metals. Copper-, brass- and nickel-plated steel are being pushed now. Nickel on copper and silver on copper are also available for suitable applications.

Libby-Owens-Ford Glass Co. has developed a new glass fiber reinforced alkyd molding material. . . . They claim it has extremely high impact strength. . . . The material can be molded with conventional machines. It is now being evaluated by defense agencies. Anticipated civilian uses include refrigerators, washing machines, electrical switch gear and electronic equipment. In general, it will be used where high impact strength, extremely good dimensional stability and good electrical properties are required.

Copper and zinc people are steamed up about Government pronouncements on long range shortages of the two metals. They claim that both these metals will come into better supply this year. The copper producers point out that World Wars I and II saw copper pulled entirely out of civilian products, too, but peace brought a rush back to the metal. . . . One neutral opinion: Both sides are right, to some extent. Aluminum will replace some copper in years to come -- but strictly on a price basis. The comparative price of aluminum should come down.

Most of the automobile companies have aluminum radiators under test. They will probably convert as soon as tests show satisfactory results. . . . One manufacturer got his fingers burned with a coated steel radiator. Lab tests checked out fine. In service, though, rust formed, clogging cooling lines. The final cost to the company when all the substitutions are made may run up to $20 million.

New development in machining metals: Instead of flooding the tool with oil from above, the oil is shot up from below in a thin stream. The oil hits the cutting edge and is vaporized. The results are longer tool life, lower cutting temperatures and easier machining of difficult metals. Titanium has been successfully turned. . . . Work is still going on to adopt the method to other machine processes besides the single tool lathe. The first production units may be ready by July.

See page 6 for "Materials Control Orders"

Now
a new High-Temperature alloy
INCOLOY
(34 Ni. - 21 Cr.)
—companion to Inconel

Metals have to be tough in heat treating equipment that is constantly exposed to elevated temperatures. Engineers know they can get that toughness in Inconel. And now Inconel has a companion alloy—Incoloy!

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Materials Control Orders

A summary highlighting actions of the NPA affecting engineering materials during the period from Dec. 11, 1951 through January 10, 1952.

● **CONTROLLED MATERIALS PLAN**

Ten Class B steel products, including die blocks, roofing, siding, nails, spikes and brads, staples, wire rope and strand, woven wire netting and welded wire mesh are now allotted as controlled materials as of Jan. 1.

Reg. 1, Amended: Manufacturers are permitted to accept shipment of controlled materials on which delivery has been delayed, until a subsequent quarter without charging the shipments against the allotment for the later quarter. Conditions under which controlled materials in inventory may be used in addition to the quantities allotted for the production of Class B products are outlined.

Reg. 1, Dir. 1, Amended: Manufacturers of Class B products may self-authorize their orders to obtain controlled materials up to specified limits as long as they do not exceed their average quarterly requirements during 1950. Those whose consumption of controlled materials falls below a second set of still lower specified limitations can self-authorize their materials up to these latter limits regardless of their 1950 consumption.

Reg. 5, Amended: Permits manufacturers to obtain materials for installation of equipment in existing buildings on same basis they are permitted to obtain minor capital additions. Establishes $1000 minimum quarterly quotas each for MRO supplies, minor capital additions and installations.

Reg. 7, Amended: Defines installers of domestic appliances, including television sets, stoves and washing machines, as repairmen, thereby granting them permission to obtain materials necessary to installation on a priority basis.

● **ALUMINUM (Orders M-5)**

Dir. 1 to M-5 permits machine tool manufacturers to substitute the symbol Z-2 for the N-8 symbol on orders for aluminum. Aluminum producers must give orders bearing this symbol the same priority now given the A to E coded orders unless order books are filled for a particular product for a particular month.

● **COPPER (Orders M-11, M-16)**

Dir. 2 to M-11 permits machine tool manufacturers to substitute the symbol Z-2 for the N-8 symbol on orders for copper. Producers must give orders bearing this symbol the same priority now given the A to E coded orders unless order books are filled for a particular product for a particular month.

NPA now authorized to direct all copper raw materials, including intermediate shapes and refined copper as well as copper scrap, to users. Small and medium-sized foundries may apply for allocations at six-month and quarterly periods, respectively. Large-size foundries must apply by the 10th of the month preceding that in which delivery is desired. All copper or copper-base alloy powder mill products are classified as controlled materials.

● **IRON AND STEEL (Orders M-1, M-6, M-47A, M-80)**

Dir. 3 to M-1 permits machine tool manufacturers to substitute the symbol Z-2 for the N-8 symbol on orders for iron and steel. Producers must give orders bearing this symbol the same priority now given the A to E coded orders unless order books are filled for a particular month.

A number of items of blast furnace and steel works equipment, including blast furnace tuyeres, bosh plates, slag thimbles, open hearth furnace steel ladles, and electric furnace charging buckets, are now Class A products. Steel producers will be able to obtain allotments of steel for this equipment which they can then pass on to the builders of these items.

The use of plain carbon steel is now permitted for any purpose by the redefining of "tool steel" to exclude plain carbon steel. High-speed steel (not less than 0.55% carbon nor more than 12% tungsten) is now permitted in hand hacksaw blades.

Dir. 1 and 2 to M-47A are revoked as no longer applying to the use of iron, steel, copper and aluminum in consumer durable goods. M-6 and its directions affecting steel distributors are revoked as of Jan. 1, 1952 and are superseded by M-6A.

● **NICKEL (Order M-80)**

Schedule C prohibits melting, processing, fabricating, delivery or use of the types of material described in its tables with a higher nickel or nickel-plus-chromium content than specifically authorized for the uses indicated. Persons ordering materials for any purpose authorized in Schedule C may not specify temperature requirements beyond those necessary for final operation. Increases of over 10% in the weight of chromium and/or chromium-nickel iron or steel alloy in any redesigned authorized application are prohibited. Deliveries of heat resistant chromium or chromium-nickel alloy iron or steel for any uses shown in Appendix 1 must be certified by the purchaser that they are in accordance with Schedule A. Exceptions to these restrictions include materials in process at the time the Schedule became effective, cases in which contracts were entered prior to the effective date of Schedule C where not commercially feasible to change specifications and where delivery will be completed within 60 days of effective date, and the materials that are to be used for Navy installations approved in NPAF-60.

● **RUBBER (Order M-2)**

Controls over the total amounts of new rubber that may be consumed are revoked. GR-S is no longer allocated but may not be obtained by those not regularly consuming or exporting this type of synthetic rubber. Appendix B of M-2 is revoked to eliminate the differences in permitted rate of production among products. Eventual private importation of natural rubber latex is provided for. Purchasers of dry GR-S are prohibited from making more than 46% of their dry purchases in the form of cold rubber. Allocation of GR-I is continued and inventories of both GR-S and GR-I are limited to 30-day supplies in consumer stocks. The amounts of rubber which may be used in the manufacture of various rubber products are modified.

Supplement 1, containing certain manufacturing specifications for tires and tubes and industrial rubber products, is revoked.

● **SELENIUM (Order M-91)**

New order prohibits: (1) Any deliveries or acceptance of deliveries after Feb. 1, 1952, with minor exceptions, not specifically authorized by NPA; (2) Use of selenium for purposes other than those for which it has been specifically allocated. Deliveries to regularly established dealers are permitted and so are the purchase of selenium scrap and delivery of recovered selenium under toll agreement or similar arrangement. Those using 1 lb. a month, or less may obtain selenium by self-certification. Inventories are limited to a 30-day supply.

Anticipated Changes: Proposed system of allocating selenium would require manufacturers in glass industry to report amount of selenium used during first six months of 1950 as a base period consumption not to be exceeded. Allocations would be on a monthly basis for use in decolorizing and coloring glass.

● **NPA REGULATIONS**

Reg. 1, Amendment 1: Inventory restrictions on natural rubber latex, nicotinamide, nicotinic acid, polyvinylacetate and phenolic resins and molding powders are removed. Inventories on specified chemicals limited to practical minimum supplies, on certain types of alloy steel, carbon steel and iron to a 45-day supply, and pig iron to a 30-day supply.

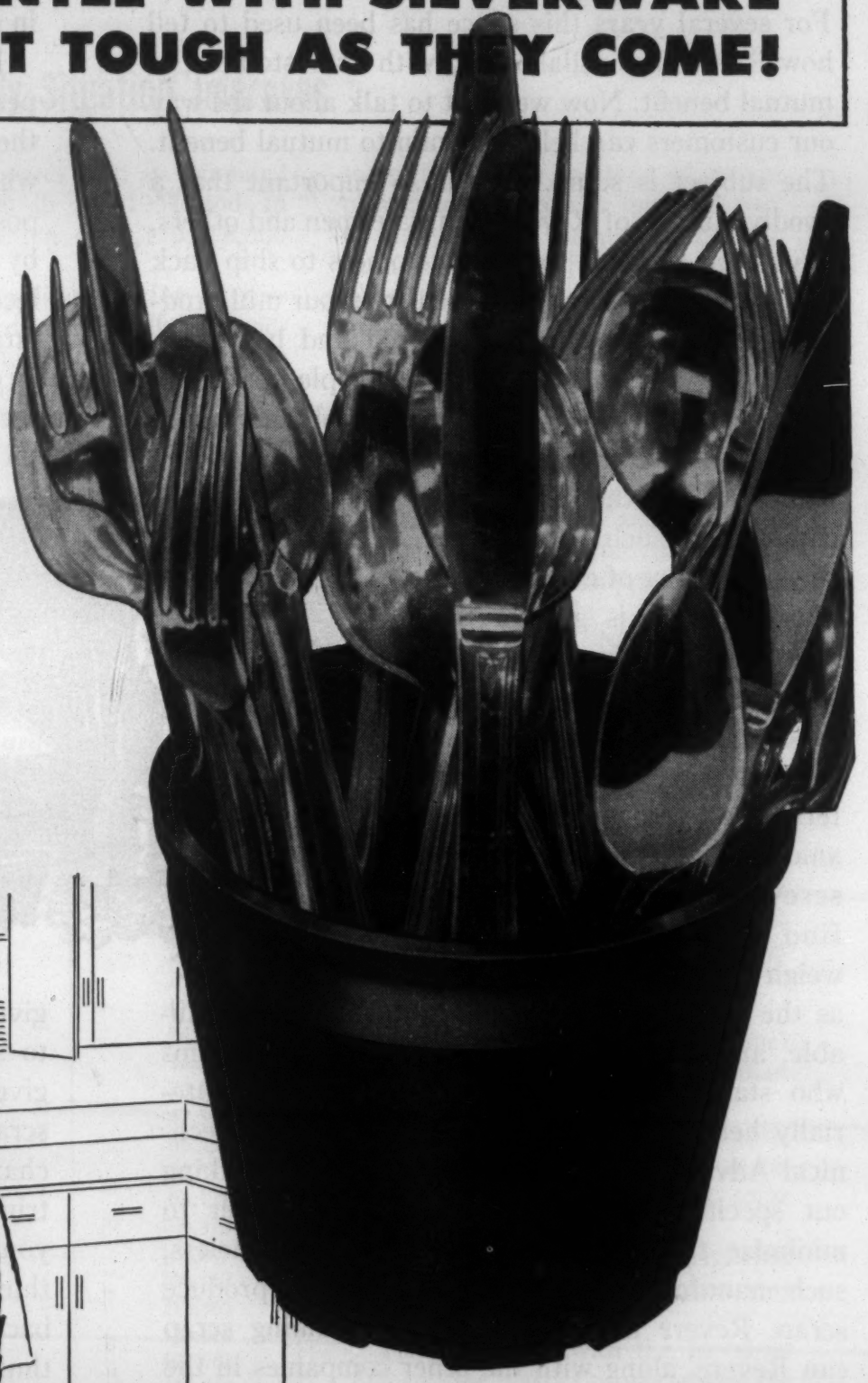
Reg. 2, Amendment 1: Permits machine tool manufacturers to substitute the symbol Z-2 for the N-8 symbol in orders for iron, steel, aluminum and copper and component parts. Producers must give orders bearing this symbol the same priority now given the A to E coded orders unless order books are filled for a certain product for a particular month.

Another development using

B. F. Goodrich Chemical Company *raw materials*

THIS silverware container is used in an automatic dishwasher, and it saves *plenty* for both the housewife and the manufacturer. Molded from a Hycar rubber-phenolic compound, it replaces containers made of brass screening. Its surface is so smooth that it won't scratch the finest silverware. It withstands the action of hot water and detergents—has a long life. It's sturdier and tougher than brass screen types, stands up far better under rough handling in assembly or shipping—an important manufacturing economy.

GENTLE WITH SILVERWARE -YET TOUGH AS THEY COME!



Hycar-phenolic compounds have many advantages that help improve products, bring cost-savings too. They impart extra toughness and shock-resistance that enable molded parts to withstand more than usual abuse. In processing, they provide better molding characteristics . . . easier flow in the mold than straight phenolics . . . resistance to cracking around metal inserts in the part.

One of the many Hycar rubber compounds may be just what you need to solve a product problem. For versatile Hycar is used as a base material . . . as a modifier for phenolic resins . . . as a plasticizer for polyvinyl resins . . . as an adhesive base . . . as a latex for coating or impregnating. For helpful technical bulletins and advice, write Dept. HQ-1, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco.

B. F. Goodrich Chemical Company
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GEON polyvinyl materials • HYCAR American rubber • GOOD-RITE chemicals and plasticizers • HARMON organic colors

BUSINESS IN MOTION

To our Colleagues in American Business ...

For several years this space has been used to tell how Revere has collaborated with its customers, to mutual benefit. Now we want to talk about the way our customers can help us, again to mutual benefit. The subject is scrap. This is so important that a goodly number of Revere men, salesmen and others, have been assigned to urge customers to ship back to our mills the scrap generated from our mill products, such as sheet and strip, rod and bar, tube, plate, and so on. Probably few people realize it, but the copper and brass industry obtains about 30% of its metal requirements from scrap. In these days when copper is in such short supply, the importance of adequate supplies of scrap is greater than ever. We need scrap, our industry needs scrap, our country needs it promptly.

Scrap comes from many different sources, and in varying amounts. A company making screw-machine products may find that the finished parts weigh only about 50% as much as the original bar or rod. The turnings are valuable, and should be sold back to the mill. Firms who stamp parts out of strip have been materially helped in many cases by the Revere Technical Advisory Service, which delights in working out specifications as to dimensions in order to minimize the weight of trimmings; nevertheless, such manufacturing operations inevitably produce scrap. Revere needs it. Only by obtaining scrap can Revere, along with the other companies in the copper and brass business, do the utmost possible in filling orders. You see, scrap helps us help you.

In seeking copper and brass scrap we cannot appeal to the general public, nor, for that matter, to the small businesses, important though they are, which have only a few hundred pounds or so to dispose of at a time. Scrap in small amounts is taken by dealers, who perform a valuable service in collecting and sorting it, and making it available in large quantities to the mills. Revere, which ships large tonnages of mill products to important manufacturers, seeks from them in return the scrap that is generated, which runs into big figures of segregated or classified scrap, ready to be melted down and processed so that more tons of finished mill products can be provided.

So Revere, in your own interest, urges you to give some extra thought to the matter of scrap. The more you can help us in this respect, the more we can help you. When a Revere salesman calls and inquires about scrap, may we ask you to give him your cooperation? In fact, we would like to say that it would be in your own interest to give special thought at this time to all kinds of scrap. No matter what materials you buy, the chances are that some portions of them, whether trimmings or rejects, do not find their way into your finished products. Let's all see that everything that can be re-used or re-processed is turned back quickly into the appropriate channels and thus returned to our national sources of supply, for the protection of us all.

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News Digest

Plastic Supply Situation Improves

The plastics raw material supply situation has improved substantially from a year ago, according to Wm. T. Cruse, executive vice president of The Society of the Plastics Industry, Inc. While one or two of the scores of different types of plastics are still a bit tight, in the main, plastics raw materials are generally available.

This condition is due to several causes. By a planned and organized program of concerted action, the plastics industry was able to correct the polystyrene plastics shortage of 12 months ago, proposing and then securing imports of benezene from France and Western Germany, from which styrene was obtained to make polystyrene plastics. Additional benezene was also procured from petroleum production. In addition, the plastics industry secured the return from Rubber Reserve of unused styrene, when the synthetic rubber program did not meet anticipated production schedules. Additional plant facilities for the production of plastics materials, such as polystyrene, polyethylene, and the phenolics, have also contributed substantially to relieving the supply situation for the molder and fabricator.

In 1952, more new plants will be completed for the production of plastics raw materials. These plants, and those completed in 1951, are an indication of the decentralization of manufacturing now taking place in the plastics industry. New plants have appeared on the West Coast and in several Southern states.

In the United States today, there are in the neighborhood of 5000 plastics companies. These concerns will produce over a billion dollars worth of plastics products in 1952. This year's production of synthetic resins, it is estimated, will be up approximately 10%, to 2,600,000,000 lb. This compares with an estimated 2,365,000,000 lb for 1951 and an actual production of 2,150,518,000 lb in 1950.

Military applications for plastics have increased substantially as products are developed from the different plastic raw materials which will withstand temperature extremes, the abuse that military products must take, and the lightness of weight required for easy handling by personnel. Consumer applications for plastics products also continue to increase, but this development has been affected somewhat by the shortage of certain plastics raw materials the first part of last year and the present cutback in the production of certain consumer items due to the country's military program.

Synthetic Resin Production
(U. S. Tariff Commission)

Year	Tons
1922	2,972
1927	6,726
1928	10,205
1929	16,518
1930	15,433
1931	17,089
1932	14,519
1933	22,600
1934	28,029
1935	47,566
1936	66,456
1937	81,515
1938	65,179
1939	106,513
1940	138,407
1941	214,162
1942	213,365
1943	326,666
1944	392,068
1945	409,010
1946	497,138
1947	625,849
1948	740,438
1949	745,555
1950	1,075,259
*1951	1,182,500
*1952	1,300,000

* *Estimated by The Society of the Plastics Industry, Inc.*

The plastic raw material supply situation, as we begin 1952, is as follows:

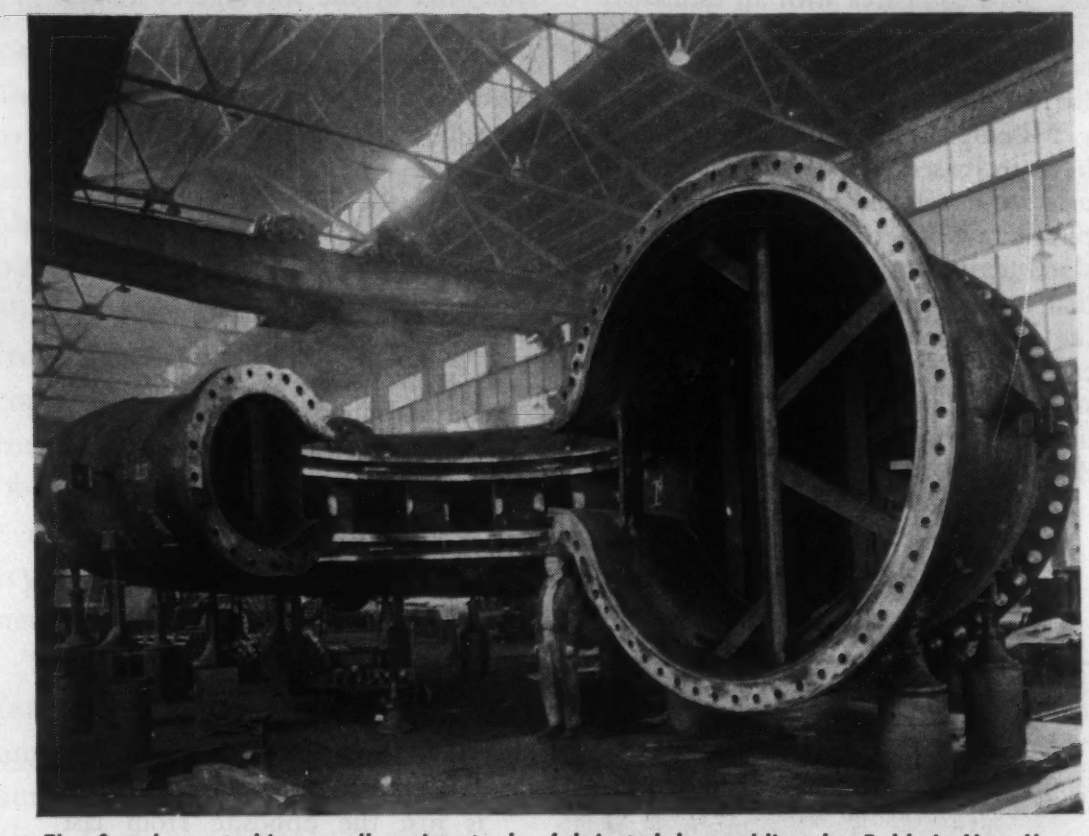
Phenolics: Supply about normal.
Ureas: Supply normal.
Melamine: Supply adequate, but future potential military demand may affect this supply later this year.
Cellulose Acetate: Normal supply.
Cellulose Acetate Butyrate: Normal supply as production recently increased.
Ethyl Cellulose: Normal supply, but future military requirements may alter this situation.
Acrylics: Normal supply.
Polystyrene: Normal supply, which is just the opposite from last year at this time when supplies were extremely short.
Vinyls: Normal supply.
Nylon (Plastic Type): Normal supply for reasonable civilian uses.
Polyethylene: Still in short supply, but increasing production is relieving this situation to some extent.
Polyesters: Normal supply, but coming military programs may alter this situation.

Hand in hand with the increased demand for plastics products goes the increase in the industry's facilities for producing these products. Since the last war year of 1945, when 818,020,000 lb of synthetic resins were produced in the United States, to this year's estimate of approximately 2,600,000,000 lb, the progress of the plastics industry has been tremendous.

News Digest

Hydraulic Pressure and Strain Gages Test Huge Welded Casing

Strain gage tests were made recently on the welded turbine scroll casing for a 70,000-hp turbine, first of two which Baldwin-Lima-Hamilton Corp. is building for the Detroit (Oregon) Dam power plant of the Corps of Engineers, U. S. Army. SR-4 resistance wire strain gages and indicator, products of the Testing Equipment Dept. of Baldwin, were used in tests supervised by R. B. Willi, manager of the Hydraulic Turbine Engineering Div.



The first large turbine scroll casing to be fabricated by welding by Baldwin-Lima-Hamilton Corp. consists of seven sections held together by bolted flanges.

The 260,000-lb turbine scroll casing is made of seven welded sections of heavy steel plate with flanges for bolting the sections together. Six of these sections are shown, indicating the size of the casing. Maximum diameter of the spiral is 40 ft, and the opening at the large end is 150 in.

In preparation for the tests, SR-4 strain gages were bonded by standard procedure at 17 critical points, including welds, areas between welds, in fillets, and on the three-point intersection of the bolting flange, rolled plate, and stay ring casting. Since these strength tests were performed in conjunction with hydrostatic leakage tests, moisture proofing was necessary. The first step was an application of cerese wax. An area around each gage was then covered with a waterproof paper which was, in turn, sealed to the casing by means of waterproof, 2-in. wide surgical adhesive tape. The whole was then painted over with an alkyd resin paint.

In order to fill the casing with water, it was sealed by means of a 150-in. dia. drum head on the intake end and by a barrel ring on the inside bore of the stay ring casting. Test pressures of 95,190 and 285 psi were applied by pump and shop accumulator system. Seven strain measurements were made with each gage at each pressure. Zero readings were repeated on each measurement and found to return to within plus or minus 5 micro-in.

Features of the shop-welded casing, the first of large size to be built in Baldwin shops, are its lower weight and cost as compared with an equivalent casing design in cast steel. Weight saving amounts to 20 to 30% and gives 15 to 20% saving in cost, at the same time insuring against defective material, Baldwin engineers report.

Ore-to-Iron Furnaces Predicted

Electric furnaces that can turn ore directly into steel are within the realm of possibility, according to H. S. Newhall, sales manager of the smelting division of Pittsburgh Lectromelt Furnace Corp. Development of this type of furnace would solve the troublesome shortage of steel scrap, since the ore would be the only raw material charged into the furnaces, Newhall said.

The prediction was made in connection with the announcement this week that Lectromelt has received an order from a South American country for two electric smelting furnaces that turn ore directly into pig iron. This type of furnace has been proved in some 25 installations in Europe, but has never before been used in the Western Hemisphere.

Capacity of the 18,750-kv ore-to-iron furnaces for Lectromelt's South American customer will be 200 tons per day. Design of the furnaces differs from the conventional electric furnace in that six carbon electrodes are arranged in a line, permitting the electrodes to be spaced to meet different ore conditions. This type of furnace layout has been used successfully in smelters for nickel, copper and titanium ores, according to Newhall.

"Ore-to-iron electric furnaces were developed for use in some parts of Europe because coke is scarce and expensive and electricity costs are relatively cheap. Their record of service cannot be overlooked, and the U. S. steel industry may be passing up a good bet if it does not pursue the development of ore-to-iron furnaces, which would eliminate reliance on the everfluctuating supplies of steel scrap", Newhall said.

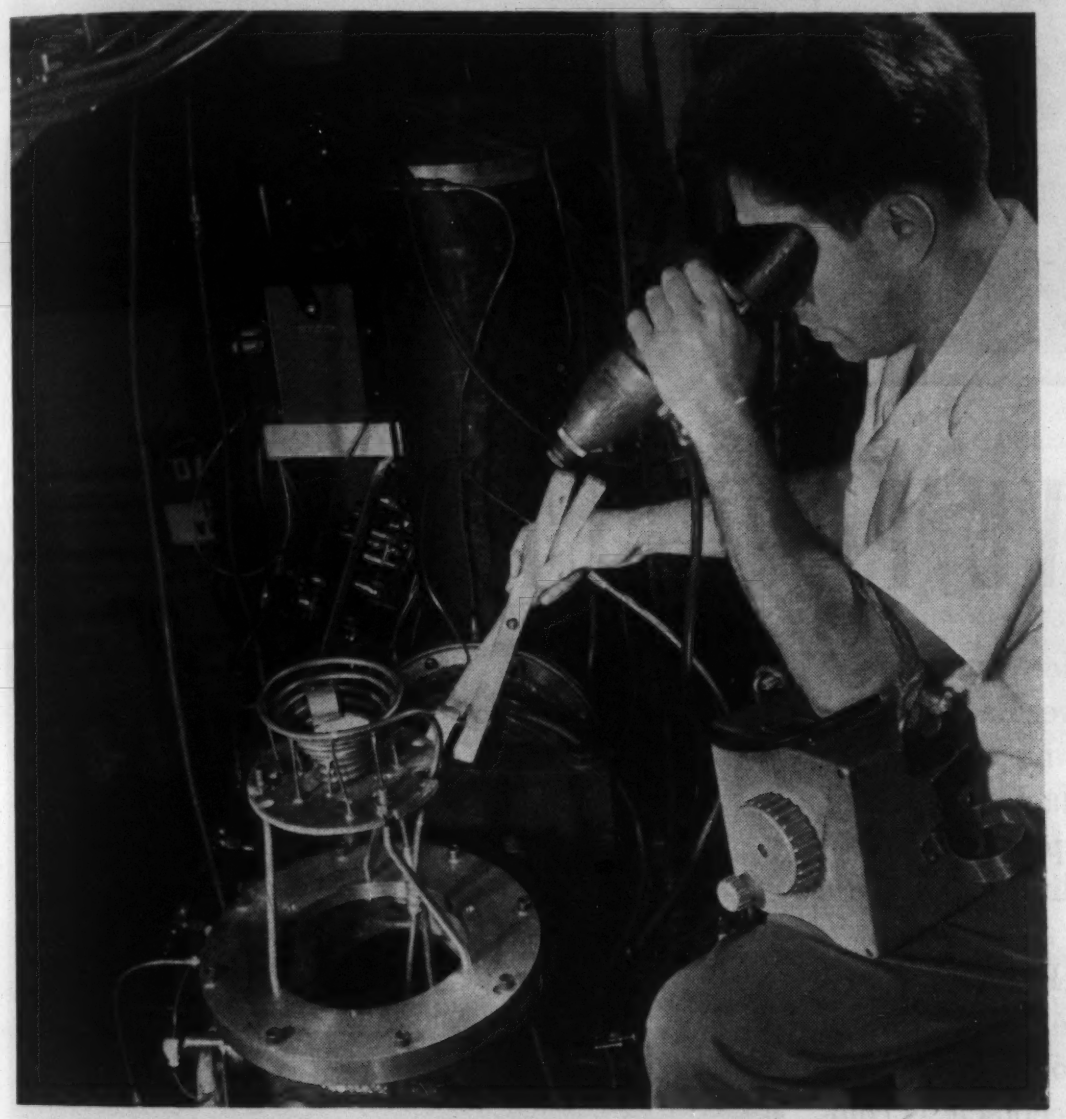
Briefs

● The Office of Technical Service of the U. S. Department of Commerce, Washington 25, D. C., is offering a 40-page Naval Research Laboratory report on luminescence of materials for $1.00.

● Arthur J. Kerbecek, Jr., Columbia University Ph. D. candidate, has developed an electrolytic method of reducing titanium from the chloride. The chloride is prepared from the original oxide.

Metals Melted in Mid Air

Westinghouse Electric Corp. engineers have turned a new trick—the melting of aluminum placed between two slightly conical horizontal coils of copper spaced a few inches apart and supplied with energy at 10,000 cycles. A switch is closed and the aluminum literally floats up into a space midway between the coils. It begins to spin furiously, bobbing slightly as though supported on invisible soft springs. Soon it glows red, begins to soften, and finally turns to a bright liquid. As it does so, it assumes the shape of a rapidly turning toy top. The power shut off, the molten aluminum drops to a crucible below, where it solidifies almost instantly.



A piece of aluminum placed inside conical copper coils carrying 10,000-cycle current is held suspended in the air by induced currents. The metal soon turns into a bobbing mass of liquid aluminum.

This bit of levitation melting was the outcome of efforts of Westinghouse Research engineers to prepare more nearly pure metals. When a high-temperature metal, such as zirconium, vanadium, molybdenum or titanium is melted in a crucible, there is inevitably some reaction with the refractory materials. But obviously, if the metal could be melted without touching anything, except molecules of gas—as if done in a sufficiently good vacuum — greater purity would be obtained. Thus, a metal could be rid of volatile impurities without absorbing others in the process. Also, alloying agents could be added to the molten metal while still suspended. The induced currents would automatically provide thorough stirring of the molten mass.

So far this process has been applied successfully to laboratory melts involving small samples, and to a very limited number of metals. Nevertheless, float melting has been employed to advantage in research for metals in lamps, electronic tubes, and other high-temperature applications, particularly where it is not necessary to carry the temperature of the metal beyond its melting point. Investigations are being continued with the aim of surmounting such problems as power requirements and physical forces that are related to the general problem.

News Digest

Columbia Researcher Develops Electrolytic Cutting Process

Sectioning of metal bars by electrolytic methods to safeguard personnel against the hazard of machine cutting of metals exposed to high levels of atomic radiation has been accomplished at the Columbia University School of Engineering under a grant from the Atomic Energy Commission. This is believed to be the first successful electrolytic cutting of metal in the United States. It was developed by George L. Kehl, associate professor of metallurgy, and Irving Moch, Jr., research associate.

Professor Kehl explained: "It would be impractical to use conventional methods in cutting material which has been exposed to considerable atomic radiation, not only because of the danger to the men, but also because the surroundings would be contaminated."

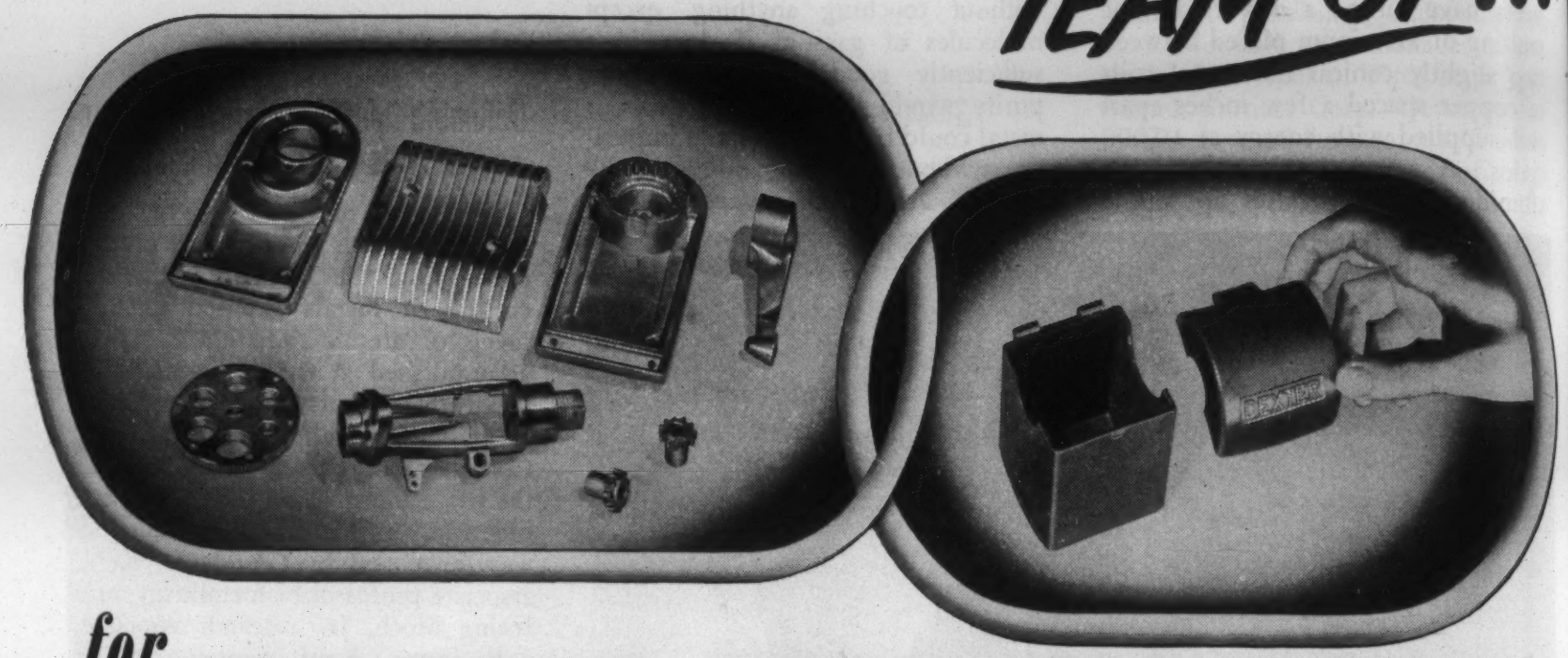
The method can be applied, when it is desirable, to cut metal bars without causing structural distortion on the cut surfaces. Steel bars $\frac{5}{8}$ in. in dia have been cut in about 24 hr by the new process, Professor Kehl said, and the cut surfaces are comparable in flatness and smoothness to the results attained by moderately fine machining methods. He predicted that, with further development of the process, very smooth and polished surfaces can be obtained.

The process consists of making the specimen to be cut the anode in an electrolytic cell and using an appropriate electrolyte and cathode assembly. The flatness of the cut surface is produced by a novel design of cathode assembly, which is the principal invention of the process.

New Process Ups Rubber Output by 26 Per Cent

A new technique that will boost production capacity of American rubber by 26% is being used at the world's largest rubber plant at Insti-

DIE CASTINGS and PLASTICS *TEAM UP...*

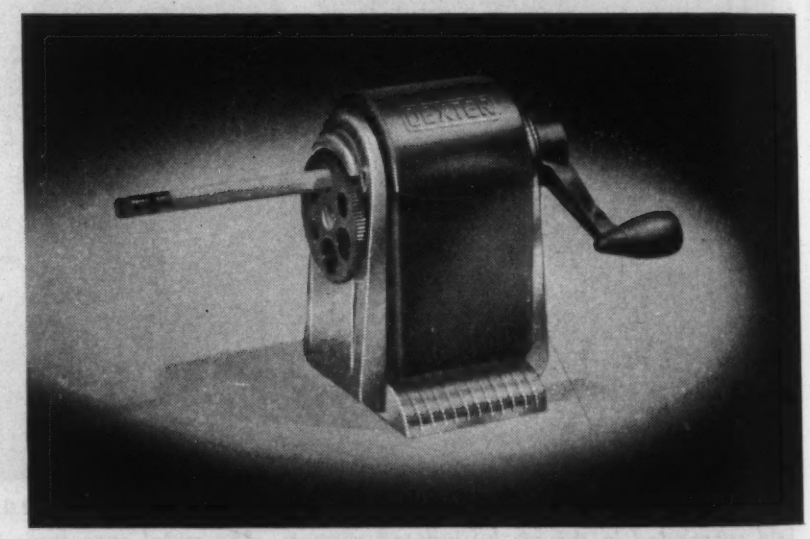


for EFFECTIVE PRODUCT DESIGNS

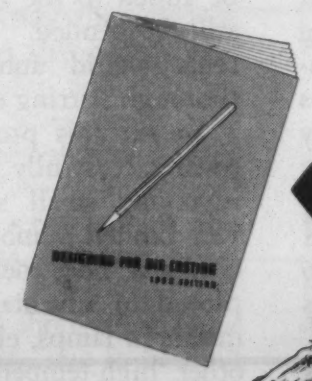
ZINC Die Castings and molded plastics generally are complementary rather than competitive. Each of these high speed production methods has its own unique characteristics for application in product engineering. That is why the two frequently team up to bring about product designs which utilize the qualities of both die castings and plastics.

Consider the handsome "Dexter Deluxe" pencil sharpener pictured here. While most of the structural and operating components of this product are ZINC Die Cast (left, above) the shavings receptacle is composed of two butyrate plastic moldings (right, above). Thus the complex operating parts are economically produced with a high degree of strength and dimensional accuracy, and the receptacle is endowed with light weight and molded-in color. The rich maroon of the receptacle provides a striking contrast with the plated ZINC Die Cast base and uprights.

Any commercial die casting company will be glad to have a representative discuss with you the qualities of ZINC Die Castings in relation to other high speed production methods and materials. Also ask us—or the die caster—for a copy of "Designing for Die Casting."



The "Dexter Deluxe" is just one of a complete line of Apsco pencil sharpeners which use zinc die castings in their assembly.



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News Digest

continued from page 11

tute, W. Va., according to W. S. Richardson, president, B. F. Goodrich Chemical Co.

The process, using sugar and other activators, was developed by B. F. Goodrich Chemical, which operates the plant for the Government, to speed the manufacture of rubber, Richardson revealed. He said the new formula is the first to be applied to the production of hot American rubber, which is made at 122 F, as contrasted with cold rubber, made at 41 F.

Hot rubber, which accounts for a substantial percentage of the current American rubber output, is in great demand for shoes, industrial materials, insulation and mechanical goods, he explained.

Malleable Iron Recommended as Alternate Material

Action contemplated by the National Production Authority in reclassifying malleable iron castings in the Defense Production Administration's List of Basic Materials and Alternates has been endorsed by Lowell D. Ryan, managing director of Malleable Founders' Society, Cleveland. Malleable castings are to be removed from Group 1 of the list ("materials for which the supply is insufficient for defense and essential civilian demands"), and put in Group 3 (materials in "fair to good supply" and "which should be used as alternates for materials in Groups 1 and 2 whenever possible"). Materials in Group 2 are considered to be in approximate balance with defense and essential civilian demand, and it is recommended that "expanded use of these materials should be avoided."

"Some capacity in the malleable industry is available as a result of cutbacks in projected passenger car production," Ryan said. "However, it must be borne in mind that different foundries make different sizes and types of castings, and, therefore, it does not follow that the foundries which have open time as a result of passenger car reduction can neces-

(Continued on page 182)

See page 15 for the PLASTICS SHOW PREVIEW

to the man who wants
UNBIASED ADVICE *on* MOLDING MATERIALS

● What molding material is *best*? Which is *cheapest*? That's where American Hard Rubber Company serves so well—and so often. We can select from literally hundreds of hard rubber compounds... many thermoplastics . . . and several unusual materials like Ace-Tex or Ace-Hide shown below . . . plus complete facilities for molding, extruding, machining, finishing, etc. Ask our advice. It's impartial. It's free.

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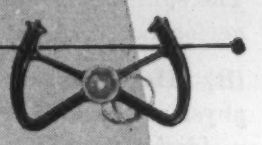
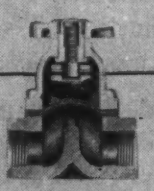
HARD RUBBER GUN PLATE

ACE PARLAN® — Tough cellulose acetate-butyrate, high impact up to 9.4 Izod. Good for housings, control wheels, handles, etc.



PARLAN STEERING WHEEL

ACE PARIAN® — Polyethylene: tensile to 3,000 psi; dielectric to 700 v/mil, unaffected by most acids, alkalies and salts. Good for chemical, electrical parts.

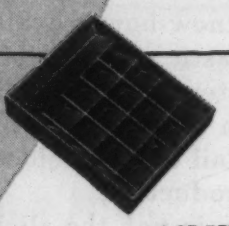


PARIAN CHEMICAL VALVE

ACE-HIDE® — New rubber-base material is practically indestructible. Impact strength to 10.0 Izod. Chemical resistant. Good for parts that take beating, like acid pails, golf-bag tops, chair arms, etc.

ACE-HIDE CHAIR ARM PAD

ACE-TEX® — Not rubber, not plastic, but a pyrobituminous molding material. Relatively low strength, high chemical resistance. Used in auto battery cases, containers, etc.



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If you're confronted with any or all of these problems there is a good chance that the right plastic materials can help you. For example:

(A) The washing machine agitator has to stand continuous mechanical stress in use. At the same time it must resist moisture and the chemical action of soaps and detergents. The specially formulated phenolic material yields outstanding performance.

(B) Here's a searchlight handle that must withstand sharp physical shock. The rubber phenolic material from which it is molded can really take it!

(C) This automotive brake plug is at times subjected to both physical shock and severe mechanical stresses. For this application, a canvas filled phenolic has proven highly successful.

(D) This distributor rotor withstands gear friction, ignition voltage, and the rugged service given every component in a farm tractor. Here again a phenolic plastic, properly chosen, does an outstanding job.

Getting the right material for the job is a big step in the success of any plastic application. And in choosing the one best material for the job, from the hundreds of materials and formulations now available, there is no substitute for experience.

For more than thirty-two years Chicago Molded has been solving problems like these—and hundreds of others—for many of America's largest users of plastics. That same seasoned know-how is available to you in perfecting the details of your plastic molding job. Chicago Molded's service extends to every step in the molding process—from design for molding through tool making, production, and finishing, down to the last detail of the molded component, ready for assembly into your product.

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PREVIEW

Fifth National Plastics Exposition

The most recent technical developments and the newest applications of plastics will be on display in Philadelphia Convention Hall when 135 leading companies in the field exhibit at the Fifth National Plastics Exposition, March 11-14. All phases of the plastics industry will be represented, including plastics producers, fabricators, molders, laminators, and manufacturers of equipment used by the industry.

The Exhibits

The theme of the exposition, sponsored by The Society of the Plastics Industry, will be Plastics Personify Progress, and it will be demonstrated by many of the exhibits displaying extraordinary advances being made by plastics in defense, industrial and consumer fields.

The exhibit hall will be open on Tuesday, Thursday and Friday from 12:30 p.m. to 5:30 p.m., and on Wednesday from 12:30 p.m. to 10:00 p.m.

The Exposition is open to the trade only. Exhibitors are sending out invitations to interested parties, so that the bulk of those attending will be buyers and users of plastics, plastics parts, and equipment.

See the following three pages for floor plan of exhibits and list of exhibitors

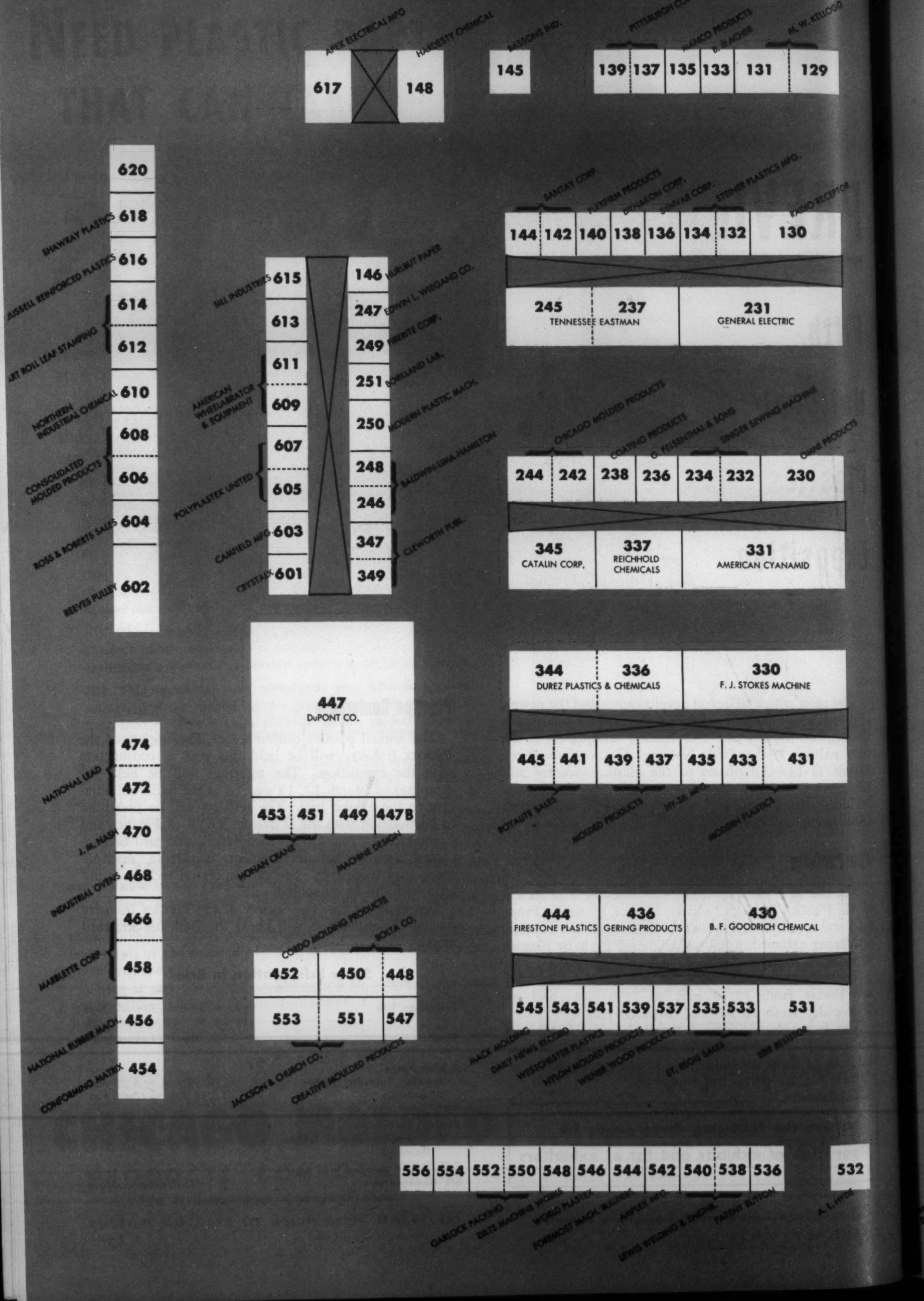
Plastics Conference

The annual plastics conference of The Society of the Plastics Industry will be held this year in conjunction with the exposition. The meetings will be held the mornings of March 12, 13 and 14 in the ballroom adjacent to the exhibit hall. The sessions will be presented in cooperation with the Wharton School of Finance and Commerce, University of Pennsylvania, and will be concerned with market development, marketing, management, and economics. Several papers on technical subjects will also be presented.

Headquarters for The Society of the Plastics Industry during the exposition will be at the Bellevue-Stratford Hotel.

Show Information in Brief

Exposition Site	*Convention Hall, Philadelphia*
Dates	*March 11 through 14*
Exhibit Hours	
Tuesday, Thursday, Friday	*12:30 p.m. to 5:30 p.m.*
Wednesday	*12:30 p.m. to 10:00 p.m.*
Plastics Conference	*Ballroom, Convention Hall*
Wednesday, Thursday, Friday Mornings	
SPI Headquarters	*Bellevue-Stratford*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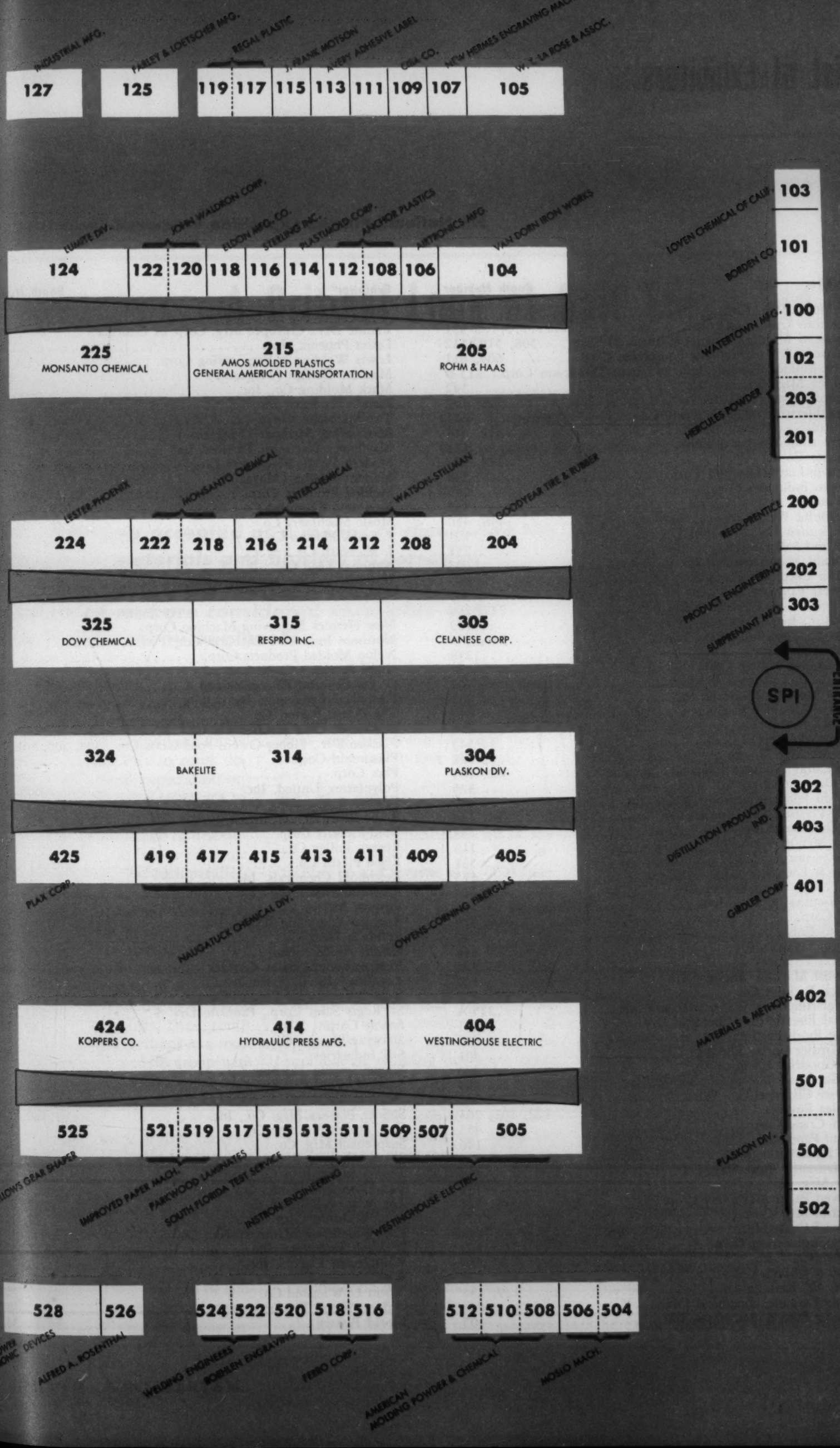
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WELDING ENGINEERS
BOEHLEN ENGRAVING
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Materials & Methods
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A Critical Look at Salt Spray Tests

by F. L. LaQUE, In Charge, Corrosion Engineering Section, Development and Research Div., The International Nickel Co., Inc.

Although widely accepted as a means of measuring the resistance of materials and finishes to corrosive environment, salt spray tests are still highly controversial and are considered unreliable and misleading by many engineers.

This article was written at the invitation of the editor. While the author has aided and abetted a number of research projects designed to study the test as a test, he has not been concerned with its actual use either as a producer or consumer of products with which it is employed as part of a specification. Consequently, he is not aware of all of its virtues and faults as used for such purposes.

The principal object of the paper is to have it serve as a basis for appraising the value of the test. Since the author is more aware of its defects than its good points he has, in effect, presented the case against the test. As a condition for preparing the paper, he arranged with the editor to submit the first draft of the manuscript in advance of publication to others who might be expected to view the matter in different lights. Comments from these several sources, plus those that may be offered by other readers, wil be published in subsequent issues of MATERIALS & METHODS.

● THE SALT SPRAY TEST is a means of subjecting materials and finishes to the action of a corrosive environment with the purpose of discovering something about their ability to resist deterioration. The usual expectation or, at least, hope is that the resistance to deterioration shown by the salt spray test will parallel resistance to deterioration under the conditions of some actual use. The fact that such parallelism rarely exists is the reason why the salt spray test is subjected to so much cussing and discussing.

One of the characteristics of the salt spray test is its inconsistency. This extends as well to some of the people who make the greatest use of it. These include, at the extremes, two groups who use it regularly perhaps as a matter of habit, and a middle group who use it only under protest when they are forced to do so by some specification requirement.

The inconsistency of the users is demonstrated principally by the two extreme groups. The first of these includes those who know most about the test and its vagaries and are most acutely aware of its limitations. These people use it in spite of this, apparently because there is nothing else immediately available that can be substituted for it for their particular purposes. The other extreme group appears to know little or nothing about the test beyond how it is carried out, do not recognize any serious limitations and are, therefore, able to remain very enthusiastic about it.

Why Use It?

When a confirmed advocate of the test is questioned as to why he is attaching so much value to it, he is likely to offer the argument that, frequently, he must make a choice amongst competing metals, coatings or metal treatments with which he has had no previous experience. The salt spray test will give him some comparative data that will serve as the basis for his decision. If the salt spray test is not used, he has the problem of working out some other kind of test or of making his choice by accepting the claims made by the advocates of the competing materials.

Dependence on the salt spray test in such cases must mean (1) that his judgment is less reliable than the results of the test, or (2) that he is unable or unwilling to devise a better test, or (3) that the advocates of the products he tests have misrepresented them in their claims. Or it may be a combination of these factors.

In view of the recognized unreliability of the test for many purposes for which it is employed, this suggests that many users of the test have rather poor judgment or that most sponsors of new materials or coatings cannot be trusted to tell the truth about their products. Since neither of these conclusions is likely to be correct, it follows that, in many cases, wiser decisions might be reached if the salt spray test were eliminated and a choice were made simply by the application of judgment to an appraisal of the claims made for the products under consideration.

Of course, it is recognized that, in the event the choice should turn out

not to be a wise one, it may be more convenient to put the blame on any sort of test than to admit poor judgment. Perhaps this is a sufficient reason for the continued use of this test —at least until something better can be developed. There remains the chance, though, that sooner or later one's judgment may be questioned if continued use of an unreliable test in place of the exercise of judgment in some other way should lead to a series of poor decisions.

Unfortunately, every so often it happens that the writer of a specification feels that he must include in it some sort of corrosion test as a method of inspection. The salt spray test is very attractive for such purposes, since the conditions under which it must be carried out have been fairly well standardized[2] and can be described fairly completely and, in some respects, rather impressively. This fills in that part of the specification quite nicely. Of course, the description of what constitutes satisfactory performance in the test is frequently troublesome. Where the uncertainty along this line is extreme, it is possible to require only that the material examined "withstand" a test of so many hours duration.

Frequently, the requirements of performance in a salt spray test called for by a specification are well beyond what is actually needed in service. For example, the components of an electronic device may be required to withstand attack for many hours in a salt fog, even though if such a fog were to penetrate within a container in which these components would be housed in service the whole device would be rendered completely inoperative before any appreciable corrosion could occur.

Test Results vs Actual Performance

When the salt spray test is used, it is assumed that the qualities of interest will be disclosed more readily by it than by some other kind of exposure, and that there will be some factor by which performance in the test can be related consistently and systematically to performance in some quite different environment. The latter requirement is important since the sort of atmosphere created within a salt spray box is not encountered very frequently in many practical applications of materials—even near the sea shore. These assumptions presumably lie behind the occasional assertion that exposure for so many hours in a salt spray box is equivalent to so many months' or years' use in some other environment.

The fallacy of this last assumption is demonstrated without regard to any feature of the salt spray test by the fact that it is impossible to define the corrosivity of a natural environment with which the salt spray might be compared. Take, for example, a marine environment which we might wish to define in terms of its corrosivity towards metals. The first question to be answered is what is a marine environment? Is it what might be encountered 80 ft from the ocean or 800 ft? Is it what exists along the windward margin of a sheltered inlet or is it what develops downwind from heavy waves breaking on an open beach? Does it refer only to materials exposed boldly to the action of the sun, wind and rain, or must it include, as well, exposure under partial shelter where fog, dew and salt particles may be encountered without the modifying effects of the sun and the rain?

All of these things have their effects on the definition of corrosivity of an environment. To complicate matters further, all materials do not respond alike to these several factors, nor do specimens of the same material exposed at the same location at different times but for the same periods corrode at the same rates. Initial rates of corrosion of zinc, for example, may vary by as much as 8 to 1, and these initial effects may influence further attack over long periods.[3]

For example, take zinc and steel and expose them at different distances from the ocean, as at the Inco Marine Test Station at Kure Beach, in an industrial atmosphere at Bayonne, N. J., as well as in salt spray tests using 3% and 20% brine. Results such as shown in Table 1 have been secured. If different people were to carry out such investigations, the data developed could be used to relate performance in the salt spray box to performance under natural conditions in the many different ways shown in Table 2.

Without laboring the point it is evident from these actual data for these materials that:

1. A precise definition of a marine environment in terms of its corrosivity towards any large number of materials is impossible. Different materials respond differently to variations in severity of exposure not only amongst materials of different kinds—zinc and steel—but amongst what might be considered minor variations of the same kind—different compositions of steel. There may be an exception here in the case of aluminum alloys, where effects of variations in composition have been roughly the same in salt spray tests as in some natural atmospheres.[4]

2. Differences in performance exhibited in salt spray boxes do not parallel differences in performance in natural environments.

3. Effects of partial shelter in natural exposures cannot be taken into account in translating salt spray test results to predictions of behavior in service.

4. Depending on the material, the natural test location and the condition of exposure—whether bold or partially sheltered—a 3% salt spray test may accelerate natural corrosion within a range from 2 to 93 times, while with the 20% salt spray the range may be from no acceleration at all to 76 times. When other materials and conditions of exposure are taken into account, many more degrees of acceleration by the salt spray tests will be achieved. So, there is obviously no one figure that may be used to relate hours of exposure in a salt spray box to any period of exposure to natural atmospheric corrosion—even in salt atmospheres.

In view of these and other possible deductions from data of this sort, it seems safe to say that any statement that exposure in a salt spray box for so many hours is equivalent to some loosely described natural exposure for so many months or years is just plain

Table 1—Corrosion of Zinc and Steel in Salt Spray Boxes and in Natural Atmospheres

Nature of Exposure	Measured Corrosion Rate, Mg/Sq Decimeter/Day			
	Zinc	Low Cu Steel 0.05% Cu	Cu Steel 0.21% Cu	Alloy Steel 1.5 Ni, 1% Cu
Natural Exposure 80 Ft from Ocean	2	89	89	4.7
Natural Exposure 800 Ft from Ocean	0.3	8	5.3	2.6
Natural Exposure 800 Ft from Ocean Partially Sheltered	...	26	11	...
Natural Exposure to Industrial Atmosphere	1.4	5	3	1.9
In 3% Salt Brine Spray Box	8	188	177	...
In 20% Salt Brine Spray Box	23	100	100	...

Table 2—Ways in Which Salt Spray Test Data Could Be Interpreted

Basis of Comparison	Days' Exposure to Natural Environments Equivalent to 1 Day in Salt Spray Box	
	3% Brine	20% Brine
Natural Bold Exposure of Zinc to Marine Atmosphere 80 Ft from Ocean	4	12
Natural Bold Exposure of Zinc to Marine Atmosphere 800 Ft from Ocean	27	77
Natural Bold Exposure of Zinc to Industrial Atmosphere	6	16
Natural Bold Exposure of Low Copper Steel to Marine Atmosphere 80 Ft from Ocean	2	1
Natural Bold Exposure of Low Copper Steel to Marine Atmosphere 800 Ft from Ocean	24	13
Natural Bold Exposure of Low Copper Steel to Industrial Atmosphere	38	20
Natural Bold Exposure of Copper Steel to Marine Atmosphere 80 Ft from Ocean	2	1
Natural Bold Exposure of Copper Steel to Marine Atmosphere 800 Ft from Ocean	33	19
Natural Bold Exposure of Copper Steel to Industrial Atmosphere	59	33
Natural Partially Sheltered Exposure of Low Copper Steel to Marine Atmosphere 800 Ft from Ocean	7	4
Natural Partially Sheltered Exposure of Copper Steel to Marine Atmosphere 800 Ft from Ocean	16	9
Natural Bold Exposure of Nickel-Copper Steel to Marine Atmosphere 80 Ft from Ocean	38	21
Natural Bold Exposure of Nickel-Copper Steel to Marine Atmosphere 800 Ft from Ocean	68	38
Natural Bold Exposure of Nickel-Copper Steel to Industrial Atmosphere	93	53

nonsense.

In addition to difficulties in interpretation associated with comparisons of rates of deterioration, there are frequent problems based on the fact that the mode or pattern of deterioration in the test does not match that observed in service. Sometimes the test can be changed to correct this situation, as was done by C. F. Nixon[5] when he was successful in devising an acetic acid modified salt spray test which reproduced very well the blistering of plating on zinc-base die castings. This blistering was commonly encountered in service but could not be reproduced in the ordinary salt spray tests without the acid addition. Perhaps other modifications of the test will prove to be useful in adapting it to other specific purposes.

Are Test Objectives Met?

Let us now examine whether or not salt spray tests fulfill the purposes for which they are made.

Measurements of the protective value of a metallic coating—To be useful for this purpose, a salt spray test would have to cause deterioration of the coating at some reproducible rate that bore some systematic relation to deterioration in service. The data already presented with respect to zinc and iron indicate that this requirement is not likely to be realized.

The usual example of the deficiency of the test in this respect has to do with the relative merits of zinc and cadmium coatings on steel. Both the 3% and 20% salt spray tests regularly show cadmium to be greatly superior to zinc. However, natural experience as well as tests in industrial and rural atmospheres have established that zinc is actually superior to cadmium.[6] In marine atmospheres, the advantage of cadmium indicated by the salt spray test is likely to be realized. However, as a further illustration of the peculiarities of salt spray tests, if natural sea water is used in the salt spray box the cadmium does not perform better than zinc—even though it does in the natural marine atmosphere. Generally, the failure of a salt spray test to give the right answer is attributed largely to the use of the wrong corrosive liquid for the spray, but here the use of what should have been the proper liquid—natural sea water from the same source as the spray encountered by the naturally exposed specimens—managed somehow to give the wrong answer. There is evidently something beyond the kind of solution sprayed that helps a salt spray box to turn out misleading information.

Another example is provided by the use of the salt spray test to make a comparison between nickel alone and a combination of nickel and copper as a foundation for decorative chromium plating on steel as used for automobile bumpers. Specimens representing various platings of this type performed substantially alike and very well in a 500-hr salt spray test. But when they were exposed under natural conditions, and especially in a marine atmosphere where the best correlation might have been expected, there was a very big difference in performance in favor of the all nickel as compared with the nickel plus copper coatings of the same total thickness. Here, the salt spray test failed to make a proper distinction between the protective value of the two types of coating.[7]

Measurements of the protective value of nonmetallic coatings—A fundamental cause of possible unreliability of a salt spray test for this purpose is the simple fact that, in most cases, the environment in the salt spray test is designed to be destructive to the basis metal rather than to the coating being studied. The behavior of the coating is then assessed in terms of the appearance of corrosion of the basis metal rather than deterioration of the coating itself.

Here, too, the difficulty of relating performance in test to performance in service is due in large part to uncertainties connected with the natural exposures. For example, it is known that the deterioration of lacquers and enamels in the atmosphere is influenced greatly by effects of light and moisture, and particularly, combinations of the two effects together or in sequence. Thus, a series of control panels exposed at the same location at different dates will exhibit gross differences in performance, depending on the prevailing light and moisture conditions.[8]

It is not surprising, therefore, that a salt spray test which cannot cover these variations in light and moisture will fail to yield consistent results. Even those coating testing devices which involve control of light and moisture effects suffer from this variability in the severity from time to time at any given place of the natural exposure conditions that the tests are supposed to duplicate.

With other types of nonmetallic coating the salt spray test suffers from other deficiencies. For example, in the case of protective oils and greases the salt spray test cannot include the

Fig 1—Effect of specimen angle on corrosion in salt spray cabinets using 20% sodium chloride and synthetic sea water.

occasionally severe effects of rain driven by strong winds that may wipe the coatings from the metal. Thus, the test will fail to measure differences in coatings with respect to their abilities to withstand such severe washing effects. Along the same line are the effects of strong sunlight in raising the temperature of naturally exposed coatings so as to cause them to soften or flow with consequent effects on their protective value not discloseable by the usual salt spray tests.

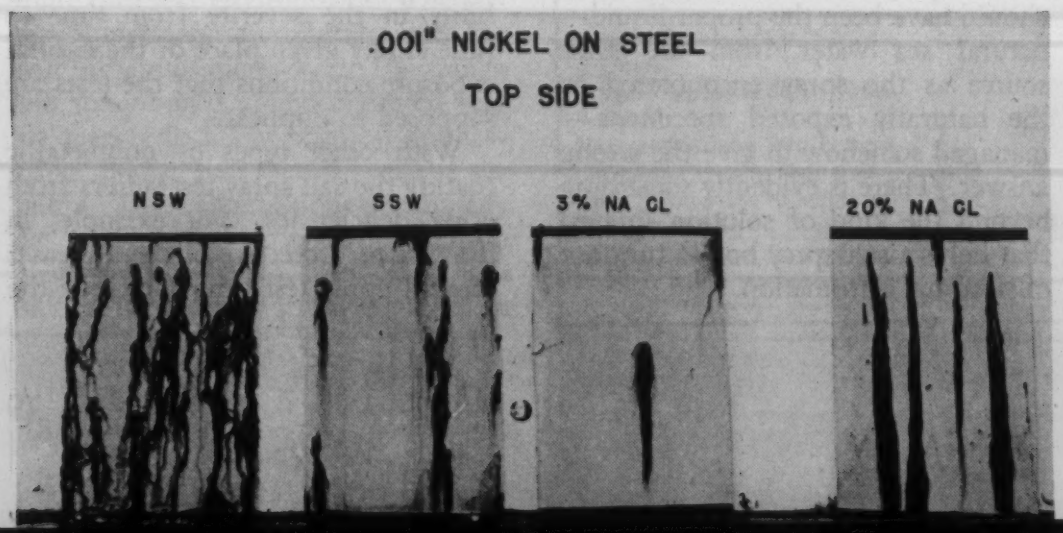
Disclosure of discontinuities in a protective coating—There is no reason why a salt spray test should not be useful for disclosing existing discontinuities in protective coatings by the appearance of visible corrosion products at such breaks in a coating—except where the coating is anodic to the basis metal and will protect it from attack in the salt spray environment, as in the case of zinc on steel.

Difficulties may appear if a test for this purpose is run too long so that the test itself produces new discontinuities in a coating which may not be distinguishable from those originally present. The test may also be rendered unreliable by the fact that some of the surface to be inspected in this way may not encounter any corrosive salt fog or condensate. Apparently the particles of condensed fog settle almost vertically so that with a specimen of complicated shape or one exposed at a peculiar angle the different portions of the surface will come into contact with more or less condensed fog or none at all.[9] Thus, the inspection by this means will not be thorough and only those discontinuities exposed at the proper angles may be detected.

This effect of the angle of exposure was illustrated by experiments[10] in which specimens of steel were exposed at several angles from the horizontal in a salt spray box. Results are shown in Fig 1.

Measurement of the thickness of a protective coating—It is known that with most coatings the number of pores or other initial discontinuities decreases in a more or less systematic way as the thickness of the coatings increases. It is also to be expected that the life of coatings attacked uniformly by the salt spray environment will be roughly proportional to their thickness. Thus, it would be reasonable to expect that a salt spray test might serve fairly well as a measure of coating thickness. This is probably the case in many instances. However, in comparing this method of appraising coating thickness with other available and usually quicker methods, one must not assume that the salt spray test will permit a more thorough inspection of the whole surface than would be secured by a series of tests at isolated spots. The reason for this is the effect of angle of exposure on the amount of corrosive fog condensate encountered, as described previously.

Fig 2—Appearance of nickel-plated steel panels after exposure in salt spray boxes using different brines. From left to right: natural sea water, synthetic sea water, 3½% sodium chloride, 20% sodium chloride.



Comparison of the corrosion resistance of different metals and alloys—This possible use of a salt spray test has been discussed in considerable detail already. It will suffice to repeat here that the relative behavior of different metals in a salt spray environment will be peculiar to that environment and may not extend to any other environment. Furthermore, the relative behavior will be determined by the concentration of brine sprayed. As illustrated by the data in Table 1, a high concentration of brine is more corrosive to zinc, a low concentration is most corrosive to iron, and a natural sea water spray is less corrosive to both metals than either dilute or concentrated brine.

While, as indicated, a salt spray test is of little or no value for comparing the general corrosion resistance of different kinds of metal, it may serve quite well to compare different modifications of the same kind of metal. While as mentioned previously it doesn't work to compare different kinds of plain or low alloy steel, it has been fairly useful in this way in connection with aluminum alloys. With these the results of salt spray tests, especially of the interrupted or cyclic type, have been reasonably indicative of the relative behavior of these alloys when exposed under natural conditions.[4]

Observation of galvanic effects—The use of a salt spray test will permit qualitative observations of the possibility of galvanic corrosion of test assemblies exposed in a spray box. However, such results are not universally applicable since galvanic relationships in a salt spray environment may not duplicate those that will exist in some other corrosive media. For example, the relationship between lead and steel in a salt spray box where lead will be definitely cathodic to steel will not be maintained in a rural atmosphere where the potential difference will be much less and lead may even be anodic to steel.

Another complicating factor is the greater opportunity in a salt spray box for soluble corrosion products to accumulate as compared with exposure to natural atmospheres. This will exaggerate secondary corrosive effects of such corrosion products, as in the case of copper and high copper alloys in contact with aluminum. For example, the apparent damaging effects of monel on aluminum indicated by a salt spray test is much greater than is observed under natural conditions of exposure—as in the cases of monel rivets used to join aluminum sheets

and monel weather stripping in aluminum windows.

Galvanic action in a salt spray box is also influenced by the relatively high electrical conductivity of the film of condensed brine as compared with the films of condensate that form on metal surfaces exposed to natural atmospheres. This tends to increase the areas involved in the galvanic couples in the spray boxes, with consequent effects on the intensity and distribution of the galvanic action. This is most important where the available area of the cathodic material is relatively large—as where a metallic coating is more noble than the basis metal.

An illustrative example is provided by the behavior of duplicate nickel plated steel specimens. With those shown in Fig 2 the development of rust in the salt spray box was restricted to a few spots where attack first started, presumably at already existing pores or other discontinuities in the coating. The steel corroding at these points evidently served to provide cathodic protection to a substantial area around each spot through which the highly conductive brine film permitted the protective current to flow. This prevented the development of new pores by corrosion of the nickel coating.

However, under conditions of natural exposure to a marine atmosphere the pattern of attack was much different, as shown in Fig 3. Here, the relatively high electrical resistance of the natural condensate films restricted any galvanic effects to the immediate vicinity of the several points of attack. Thus, not only was the intensity of galvanic corrosion of the steel reduced by restricting the cathodic areas affecting each anode, but, at the same time, the feeble galvanic currents were unable to prevent the development of new corrosion sites. This resulted in the much more widespread distribution of less severe rusting of the naturally exposed panels as compared with their mates exposed in the salt spray box (Fig 2).

Detection of free iron — The salt spray test will detect the presence of free iron contaminating the surface of some other metal by the development of visible rust. However, it is unsatisfactory for this purpose when the other metal is a stainless steel which may quite readily develop rust stain on its own account and thus create confusion between such indigenous rust and that caused by any free or tramp iron that may be imbedded in its surface.

Such development of rust stains on stainless steels exposed in a salt spray box is very likely to start in crevices wherever the specimens rest on or are held by their supports. This incidence of rust staining in the test will be much greater than under most service conditions where similar corrosion stimulating crevices will not exist to the same extent. It may be noted here that fairly rigorous studies by subcommittee IV of ASTM Committee A-10[11] led to their conclusion that salt spray tests of stainless steels were of little value.

Upon reviewing these possible uses of a salt spray test and its limitations with respect to each of them, one might reasonably ask is a salt spray test actually good for anything? The

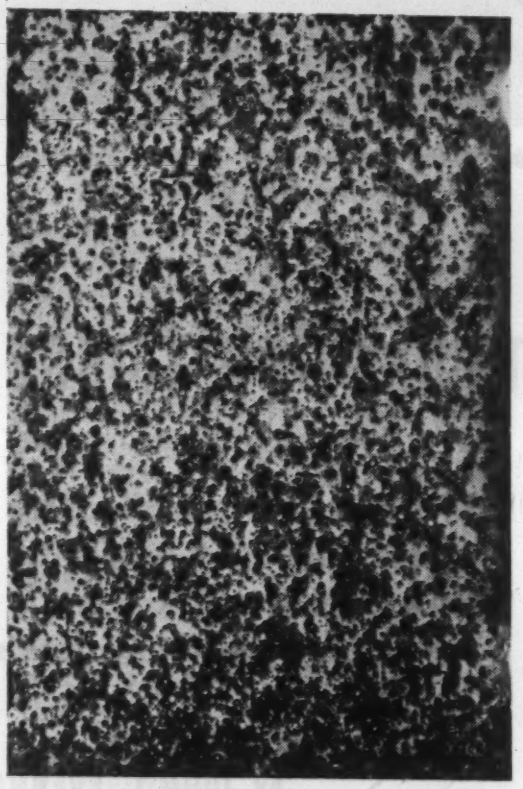


Fig 3—Appearance of panels duplicating those in Fig 2 after exposure in natural marine atmosphere.

answer to this need not be no, even though some may feel that it should be until some of its deficiencies have been eliminated by further study and improvement.

A salt spray test can be made useful for inspecting different lots of the same product once some standard level of performance has been established. This latter is rendered difficult by numerous observations that failure in a salt spray test is not always followed by failure in service nor does a good performance in a salt spray test guarantee satisfactory behavior in service.

For example, the salt spray test has been used for want of a better test for the inspection of decorative chromium plating on automotive parts. It has not been wholly satisfactory for this purpose and its use has been the basis of numerous disputes between purchasers and suppliers. Nevertheless, the fact that it continues to be used so extensively in this field must mean that it has a recognized value — probably principally as a means of disclosing gross defects that might escape detection by other means of inspection.

However, there seems to be ample evidence to question placing major reliance on this test as a tool of research in the development of improvements in such decorative plating.

It is the author's opinion that the major weakness of the salt spray test is its inadequacy as a research method. Where it has been used for such purposes it has delayed progress. It will continue to be a handicap so long as it is substituted for special tests designed to study individually or in combination those factors that actually determine the overall quality of products that require improvement.

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The excellent spinning, drawing, and stamping qualities are shown in these representative products made of 80/20 material by customers of Eastern Brass & Copper Co.

Copper-Clad Aluminum Can Conserve Copper in Many Uses

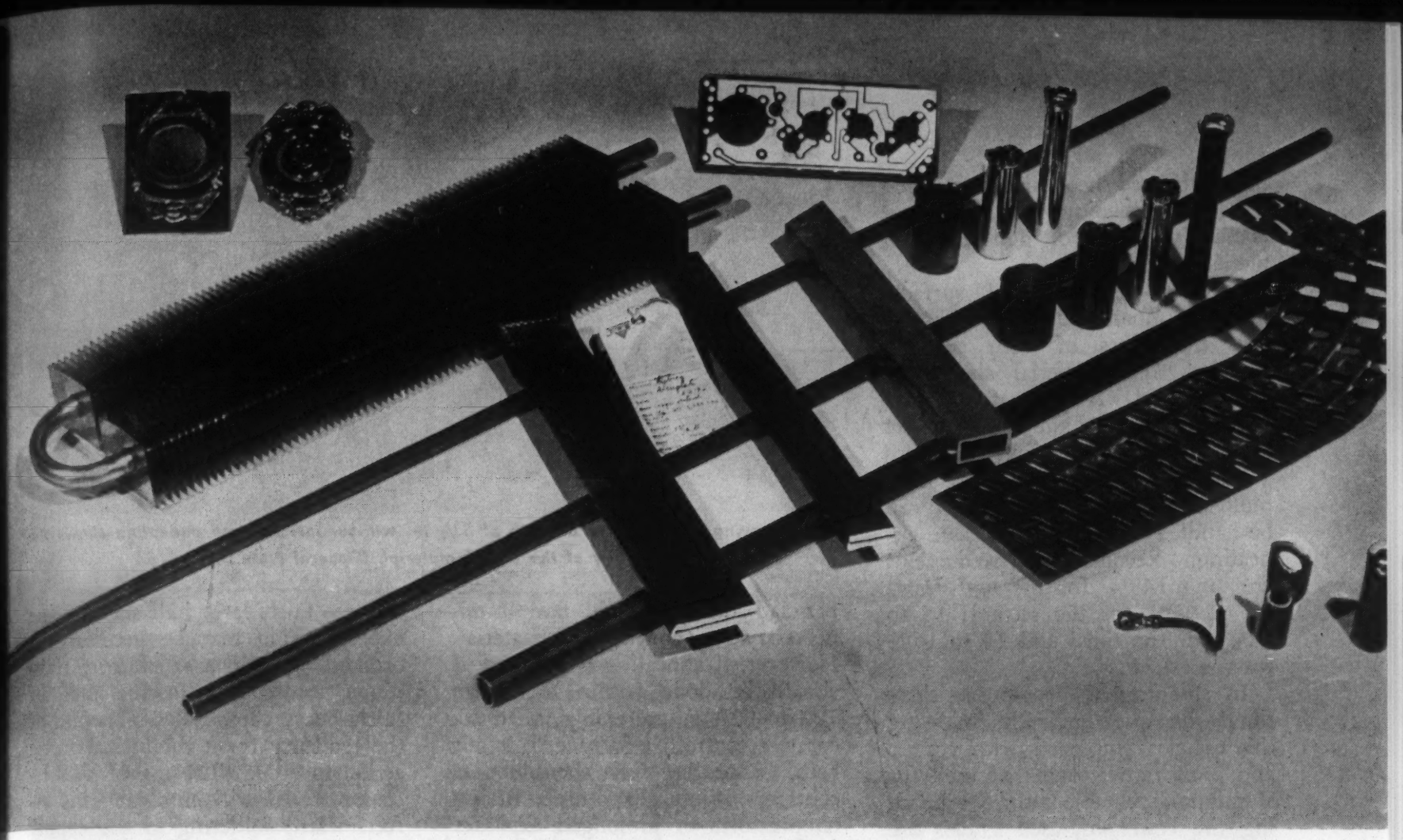
Developed originally for service in the electrical industry, this clad material is finding new fields of application where copper is scarce or where properties not obtainable in a single metal are needed.

by **JOHN L. EVERHART**, Associate Editor, Materials & Methods

● THE CLADDING OF one metal with another can have a number of objectives. These include reduction in cost, improvement of the surface properties and appearance, development of properties not obtainable in any single metal, and extending the available supply of a metal in short supply. One of the materials on the national critical list is copper. For certain purposes, the copper supply can be extended by using a thin layer in conjunction with some other metal. Such a material is copper-clad aluminum.

Copper can be bonded to aluminum by a combined welding and hot-rolling process, but the production of a satisfactory composite metal requires careful control. A compound layer may form at the interface under improper bonding conditions or subsequent annealing. Since this compound is quite brittle, the working properties of the metal can be seriously affected. This makes it essential that the manufacturing technique include all precautions necessary to avoid the presence of this compound. Since no binding agent is employed, the properties of the clad metal produced in this fashion are a combination of those of copper and aluminum.

Copper-clad aluminum is manufactured with copper on one or both sides. The most popular applications for single-clad material call for an 80/20 ratio (80 aluminum, 20% copper by thickness) but other ratios can be supplied with the copper running from 5 to 50% of the total thickness. In double clad, the most common ratios are 5/90/5 and 10/80/10. The minimum amount of copper for a given overall thickness can best be determined by studying the application. Where an impervious layer of copper free of pinholes is required, a minimum thickness of copper of 0.001 in. is recommended. Where the copper layer is employed merely for ease in soldering and an occasional pinhole is not objectionable, thinner layers can be used. At present, copper-clad aluminum is available commercially in the form of sheet or strip and in the form of bus bar. Tubing has been announced also, while wire has been produced in



Copper-clad aluminum is produced in the form of sheet, tubing and bus bar, and fabricated into a variety of objects. (General Plate Div.)

limited quantities.*

The physical properties of the usual commercial grades are given in an accompanying table. The composite material has a definite advantage over copper in density. The thermal and electrical conductivities of copper-clad aluminum depend upon the ratio of copper to alumninum but in general are the same as the theoretical values for these ratios, the only exception being that there is no additional thermal resistance at the bond such as would result if separate sheets of the metal were merely held together by pressure. The coefficients of thermal expansion and the moduli of elasticity of the composite metals are quite close to those of aluminum. In general, the mechanical properties resemble those of aluminum more closely than those of copper.

The copper and alumnium surfaces of the composite sheet react with chemicals in the same manner as electrolytic copper and commercial aluminum. Parallel tests made by exposing copper - aluminum - copper sheets and electrolytic copper to high sulfur flue gases, ammonia, steam and water showed similar corrosion properties for both materials. The possibilities of corrosion-couples or galvanic action should not be overlooked, however, and for use in some environments it would be necessary to protect the cut edges of the sheet to prevent such effects.

Fabrication

Although many forming operations follow those used in working copper or aluminum sheet, there are certain precautions which are necessary in working with the composite material. If the bond is properly made in the first place, it seems to improve with cold working and, therefore, the thinner gages can be expected to have a bond equal or superior to that in the heavier gages. However, in finishing operations, it must be remembered that in thinner gages, the copper layer is also thinner and can be cut through if care is not exercised in buffing, sanding or similar operations.

It is recommended that annealed sheet be used for spinning, deep-drawing, sharp bending and emboss-

Permissible Bending Radii

Clad Material			Condition		
Cu	Al	Cu	Soft	Half Hard	Hard
10	90	..	0.8–1.2T	2.5–4T	6–8T
5	90	5	2–3T	5–7T	10–13T
20	80	..	0.5–0.8T	1–1.4T	2–3T
10	80	10	1.5–2T	4–5T	8–10T
30	70	..	0.5–0.8T	1–1.4T	2–3T
15	70	15	1.5–2T	4–5T	8–10T

NOTES:
Lower value—bends perpendicular to rolling direction.
Higher value—bends parallel to rolling direction.

*** General Plate Div. can supply sheet or strip up to 8 in. wide in thicknesses below ⅛ in. Tubing has been announced also, and wire has been produced in limited quantities.**

Eastern Brass & Copper Co. states that they can supply sheet or strip up to 23 in. wide in thicknesses below ⅛ in. and up to 39 in. wide on special order, while bus bar is produced in sections 6 in. wide and up to ½ in. thick.

ing. Half-hard sheet can be employed for shallow shaping while hard sheet is suitable only for punching and moderate bending.

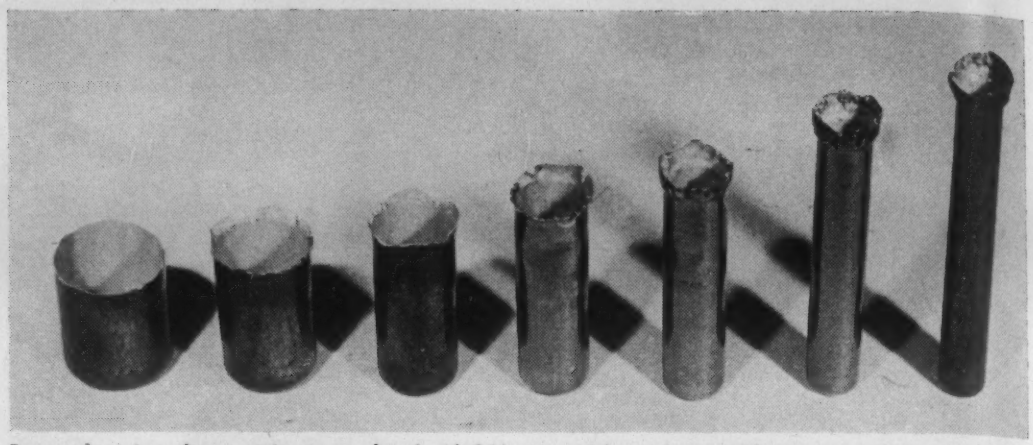
In deep-drawing, tool surfaces must be smooth, and it is advisable that the edges of both dies be rounded. The material should be well greased. A pneumatic blank-holder is desirable and should be set loosely to prevent wrinkling. With a suitable combination of dies, most multistage drawing operations can be handled without intermediate annealing. Recommended reductions are 40 to 43% for the first draw; 20 to 25% for the second; 15 to 18% for the third and 14 to 15% for the fourth.

In spinning, the composite sheet should be upset gradually following the practice employed with copper and brass rather than that used for aluminum. Suitable radii for bending the commonly-used grades are given in an accompanying table. For hand straightening, wood or rubber hammers should be used to avoid damaging the copper layer. For machine straightening, standard machines with smooth rolls are satisfactory.

Copper-clad aluminum can be machined satisfactorily with the same tools used for aluminum. As a general rule, in drilling, cutting threads, or similar operations, it is preferable to place the copper-side on top in working with material clad on only one side. Before cutting threads, it is advisable to countersink the predrilled hole.

Annealing

Ordinarily, the fabricator of copper-clad aluminum will find it unnecessary to anneal the material. However, if annealing is required, it should be done within the range 700 to 750 F, preferably in an accurately controlled furnace or a salt bath. Annealing time should be as short as possible. Exposure at higher temperatures or prolonged exposure below 750 F results in the formation of a compound layer at the interface which can modify the properties of the clad-material drastically.

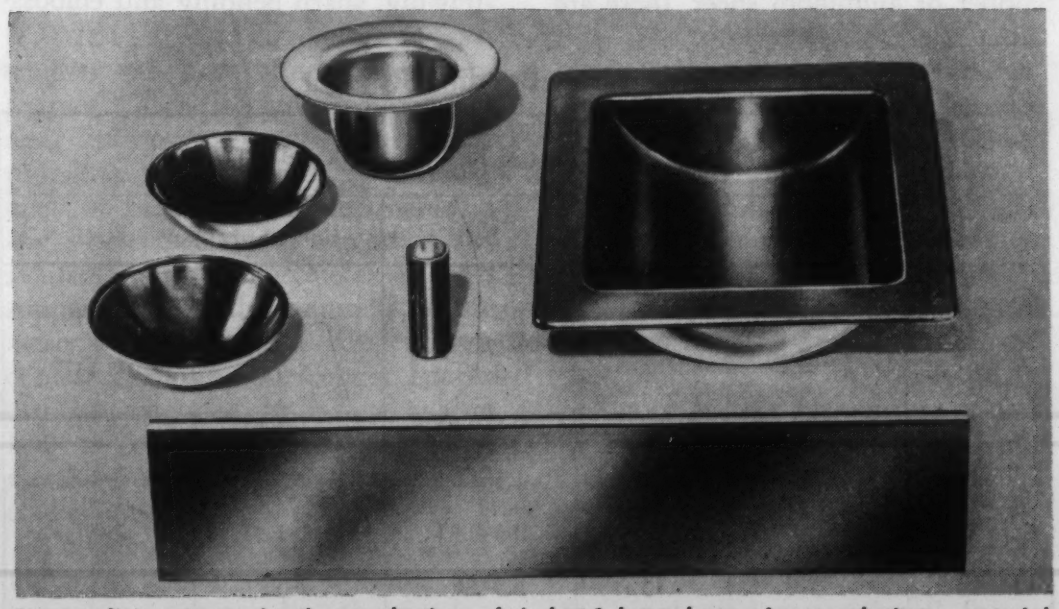


Deep drawing from strip to a depth of 3½ in. without intermediate annealing shows the ductility of the 80/20 material. (General Plate Div.)

Joining

Since a brittle copper-aluminum compound can be formed on melting, welding requires considerable care. However, satisfactory joints can be made by the spot-welding of single-clad material if the aluminum surfaces are placed in contact with each other.

Soft soldering of the copper layer offers no problem. Since the soldering of the aluminum side is more difficult, this should be avoided where possible by designing the parts to produce facing copper sides. In joining two fairly large half shells, some experimenting may be necessary in order to develop a satisfactory technique, particularly in the case of fairly heavy copper layers because of the tendency for a thermostat metal action to occur. The use of double-clad material will eliminate this effect. Hard soldering to the copper layer has been done but involves a special technique which allows the aluminum to be cooled artificially to keep it from reaching the melting point.



Intermediate stages in the production of industrial products. As a substitute material, copper-clad aluminum bus bar (bottom) can help relieve the copper shortage. (Eastern Brass & Copper Co.)

Applications

For electrical applications, copper-clad aluminum has been used widely in Europe and to a lesser degree in this country for several years. The major use in this country has been by the manufacturers of split bolt and washer type connectors for the terminals of heavy aluminum conductors. Washers or shims made from single-clad material are used with the aluminum side in contact with the aluminum conductor and the copper side in contact with the terminals of the switch gear. Through this arrangement, the dissimilar metal contact is for all practical purposes hermetically sealed and protected from corrosive conditions, with the exception of the edge. Edge corrosion has no serious consequences. With the increasing use of aluminum cables in smaller sizes, greater interest in the manufacture of pressure-type terminals from this material has developed. Other applications in this field include switch blades, contacts, and lamp bases and sockets to replace brass.

Copper-clad aluminum is particularly valuable for high-frequency applications. Since high-frequency currents travel on the surface of the conductor, the effective conductivity of copper-clad approaches that of solid copper, and advantage has been

Physical Properties

Clad Material			Density, Lb/Cu In.	Specific Gravity	Thermal Cond., Btu/Hr/Sq Ft/-Ft/°F	Coef. of Exp. per °F 32–212 F	Elect. Res. Microhm-Cm	Elect. Cond., % IACS	Mod. of Elast. (Tension), Psi
Cu	Al	Cu							
10	90	..	0.12	3.33	137	13.0	2.73	63	10,400,000
5	90	5	0.12	3.33	137	13.0	2.72	63	10,100,000
20	80	..	0.14	4.00	144	12.5	2.63	66	10,800,000
10	80	10	0.14	4.00	144	12.5	2.59	67	10,800,000
30	70	..	0.16	4.50	154	12.0	2.52	69	11,000,000
15	70	15	0.16	4.50	154	12.0	2.44	71	10,500,000
40	60	..	0.19	5.22	...	....	2.36	73	.....
20	60	20	0.19	5.22	...	....	2.28	76	.....
50	50	..	0.21	5.85	...	....	2.20	78	.....
25	50	25	0.21	5.85	...	....	2.17	79	.....

taken of this fact in the production of various radio and electronic components, particularly for airborne equipment where the reduction in weight of the part is advantageous. Copper-clad aluminum is widely used for bus-bars in Germany as a method of conserving copper.

The heat conductivity of copper-clad aluminum is considerably better than that of brass and, therefore, it has been used in heat transfer assemblies. An additional advantage is the saving in weight because of its lower density. Fin and tube type radiators have been produced by forming tubes from double-clad aluminum and soft soldering fins to these or to solid copper tubes. Among other applications based on the heat conductivity are condensers and hot water heaters.

The composite material can be deep-drawn readily into kitchen appliances and utensils. For this purpose, single-clad material is used with the aluminum side forming the internal surface and the copper side the external. Uniform heating of pots and pans is obtainable in this manner while copper does not come into contact with the food.

Silver-plated hollow-ware can be produced similarly. Since aluminum resists silver plating, it is possible to deposit silver only on the outside of the vessel if single-clad material is used with consequent savings in plating costs.

Copper-clad aluminum is a satisfactory metal for coining, giving sharp impressions. It is used for badges, medals, tags and similar objects which can be plated if desired. Another large potential use is in jewelry to replace the copper-base alloys that are drastically limited for such service at present.

Reflectors and flood-light fixtures produced from aluminum clad on one surface with copper can be plated on one side only. Since the metal does not spring-back in forming, permanent parabolic reflectors are readily obtainable.

Thin gage single-clad material has been used experimentally in stamped circuits. Copper is the preferred material for such use but the aluminum side can be bonded more readily than copper to the phenolic backing, with a resulting increase in strength.

Experiments on plates for off-set printing have indicated that copper-clad aluminum has definite possibilities in this field. The plates are lighter than those normally used and have less tendency to stretch; thus, better registry is obtained.

Mechanical Properties

Clad Material			Condition	Yld. Str. 0.2% Offset, Psi	Ten. Str., Psi	Elong., %	Vickers Hardness No. 100 G. Load 0.020-In. Sheet		Bend No. Radius 5 T	Erichsen Value Mm (0.020-In. Sheet)	
Cu	Al	Cu					Al-Side	Cu-Side		Cu-Outside	Al-Outside
10	90	..	Annealed Cold-rolled[1]	5700–7100 18,500–21,400	12,800–15,600 25,600–28,500	28–31 5–7	33 47	70 105	14–22	9.2	9.1 .....
5	90	5	Annealed Cold-rolled[1]	5700–7100 19,000–22,800	12,800–15,600 25,600–28,500	28–31 5–7	....	72 107	8–16	9.0	....
20	80	..	Annealed Cold-rolled[1]	6400–7800 22,800–25,600	14,200–17,100 27,000–30,000	30–33 5–7	33 46	70 105	18–26	9.5	9.4 .....
10	80	10	Annealed Cold-rolled[1]	6400–7800 22,800–25,600	14,200–17,100 27,000–30,000	30–33 5–7	....	70 105	12–18	9.2	....
30	70	..	Annealed Cold-rolled[1]	7100–8000 24,200–27,000	17,100–19,900 28,500–32,800	34–36 6–8	33 47	69 104	23–30	9.8	9.7 .....
15	70	15	Annealed Cold-rolled[1]	7100–8000 25,600–28,500	17,100–19,900 28,500–32,800	34–36 6–8	....	70 105	16–20	9.45	....

[1] *Cold-rolled, 50% reduction in thickness*

Carbon Steels Successfully Welded by Inert-Gas-Shielded Metal Arc Process

by H. T. HERBST and T. McELRATH, JR., Development Engineers, The Linde Air Products Co.

● SUCCESSFUL WELDING OF carbon steels by the shielded inert gas metal arc process (sigma welding) is now possible with the use of a new argon-oxygen gas mixture. This mixture, containing approximately 5 oxygen and 95% argon (marketed as Linde argon-sigma grade), permits welding at higher speeds without undercutting, improves coalescence of the weld metal at increased welding speeds, and provides good stability and low spatter rate.

The significant factor in adding oxygen to argon in the welding of carbon steel is the increase of rate at which drops of metal are discharged from the end of the welding electrode. This drop rate is in the neighborhood of 30 to 50 times higher in the argon-oxygen mixture than in the pure gas atmosphere, as determined by means of high-speed motion picture photography.

Practical effects of these changes are:

1. Much lower currents can be employed for a given size of electrode. This effect allows use of much lower current densities and selection of welding rod one or two sizes larger than possible when using pure argon.

2. Welding speeds are at least twice as high without encountering lack of coalescence, undercutting or porosity. For instance, in argon atmosphere, lack of coalescence occurs when welding ¼-in. steel plate at 20 in. per min, thus restricting the speed to about 15 in. per min. With the argon-oxygen mixture, speeds up to 30 in. per min produce good welds.

3. Straight-polarity direct current welding is usable. In pure argon, straight-polarity current is practically unusable, but with argon-oxygen mixture, satisfactory results have been achieved where minimum dilution and less arc blow are desired.

This compresser housing made of carbon steel was welded by the inert-gas-metal arc process using a mixture of oxygen and argon gas.

Scope of Process

It is possible, under some special conditions, to make satisfactory sigma welds on material as thin as 1/16 in. However, the process has an inherent characteristic which sometimes becomes a disadvantage—the heat required for fusion is more or less unalterably tied to the deposition of weld metal. In welding thin material, the amount of rod melted is frequently considerably in excess of the desired amount. This is usually true in butt welds in material of about ⅛-in. thickness and less. In fillet and lap welds, extra reinforcement is provided which meets the requirement for metal to produce the fillet. However, in butt welding materials thinner than ⅛-in., greater economy can generally be realized through the use of Heliarc welding because of the control that can be exercised over the amount of metal deposited.

Plate thicknesses of from 3/16 to ¾-in. should generally be satisfactory for operation with the sigma process using beveled edges, while for heavier plates "U" grooves may offer economy through decreased weld metal requirements.

Cross-section of sigma weld deposit of a low-carbon rod on a high-carbon base metal.

Sigma welding is applicable to low-alloy steels in these ranges of thickness. Killed or semikilled materials are readily handled by the process, but porosity may be a factor in rimmed type steels. Laminated steels are more difficult to handle and will produce more porosity than sound plate. However, this problem is not particularly different with the sigma welding process than with other methods of welding. It should be noted that the process shows considerable promise for those alloy steels of composition subject to underbead cracking associated with hydrogen. Here, as with the Heliarc process, the absence of hydrogen is particularly effective in preventing underbead cracking.

For low-carbon steels, that is, less than 0.10% carbon, a weld with approximately the same carbon content will be obtained using rod of substantially the same composition. Where the carbon content of the rod is in the neighborhood of 0.30%, there may be a 15 to 20% loss of carbon in transfer across the arc. Therefore, where heat treating requires maintaining in the weld metal the same carbon content as in the base metal, the rod should have more carbon than is required in the weld.

Weld Properties

Under suitable operating conditions of speed and gas shielding, weld soundness depends on presence of deoxidizing elements. Killed, semikilled and rimmed plate welded with a rod containing deoxidizing elements will result in porous-free welds. In general, lower current densities must be used when welding rimmed plate than are permissible for killed material.

Mechanical properties of sigma welds in steel depend principally on the rod composition and secondarily on the plate joint preparation. A low-carbon rod with manganese, and of the killed type, produces in ¾-in.

Table 1—Comparison of Mechanical Properties, Mild Steel Weld Metal (As-Welded)

	Ten. Str., 1000 Psi	Yd. Str., 1000 Psi	Elong. in 2 In., %	Reduction of Area, %
E6010, E6011	62–73	52–61	22–28	35
Sigma Weld with Manganese-Silicon Killed Rod	64–71	52–56	26–33	27–65
E6012, E6013	68–78	55–65	17–22	25
Sigma Weld with Manganese-Silicon Killed Rod plus Chromium	72–78	55–63	16–18	30–39

plate, welds having tensile strengths in the range of from 64,000 to 71,000 psi. The lower figures occur with 70-deg welding vees and lower current values, while a 50-deg vee and high currents produce higher tensile values. With this type of rod, mechanical properties and radiographic properties equal to those specified for 6010 and 6011 flux-coated electrodes are obtained. Higher strengths suitable for low-alloy steels and equal to mechanical properties of the 6012 and 6013 classifications are obtained with a rod similar to the above but having some chromium as an alloy. The radiographic quality of such sigma welds should, however, be somewhat superior to that normally expected from electrodes of the 6012 classification.

Applications

Typical welding data for hand and machine welding several plate thicknesses are shown in Table 2. Several recent applications of the sigma welding process will serve to illustrate some of the diverse ways in which the process can be used.

On certain designs of compressor housings, the possibility of flux entrapment with coated electrode or submerged arc welding favors the use of sigma welding. Sigma grade argon allows the use of 3/32-in. dia rod on this 3/32-in. steel with direct current, reverse polarity.

An example of the use of the sigma process for a welded joint with direct current, straight polarity is in the fabrication of structural brackets of 1/4-in. plate. These brackets involve fillet welds joining plates in three planes. This plate geometry is conducive to excessive arc blow conditions using reverse polarity. The use of sigma grade argon made possible use of the straight-polarity connection and 1/16-in. dia rod. This combination largely suppressed the arc blow trouble and allowed continuous welding into the compound corners. The average welding speed was 25 to 30 in. per min for five 1/4-in. fillets totaling 59 in. in length.

In addition to joining operations, proper selection of welding conditions makes possible build-up operations with a minimum of base metal pickup. This type of operation is best performed with straight polarity due to the ease with which base metal melting can be controlled. The accompanying illustration shows deposits of a low-carbon rod on a high-carbon base material. Average penetration is less than 1/16-in. Using welding rod containing 0.028% carbon, a base metal containing 0.50% carbon weld metal analysis showed a carbon content of 0.11%.

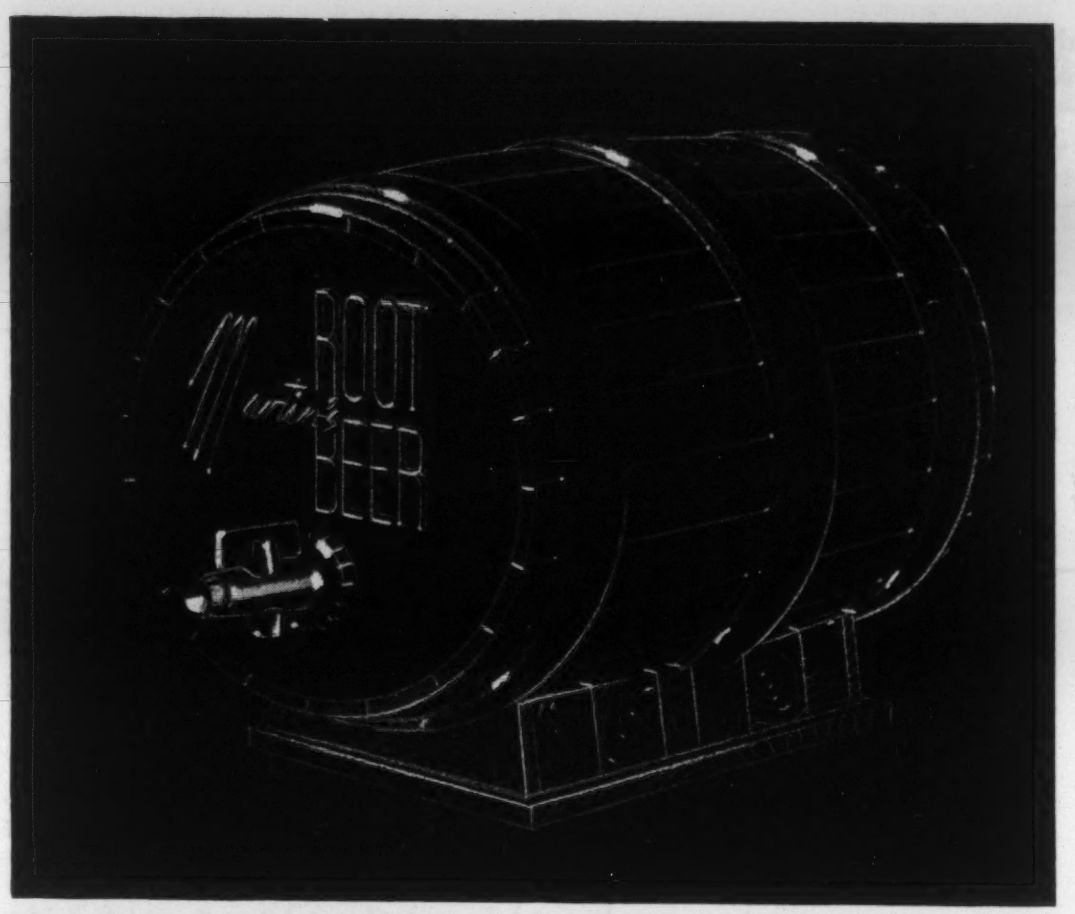
A wide variety of bead shapes and deposit rates can be achieved through the use of a weaving technique and/or rod additions other than the electrode.

This article was adapted from a paper presented at the 32nd Annual Meeting of the American Welding Society.

Table 2—Welding Data for Hand and Machine Sigma Welding of Mild Steel

Thickness, In.	Type of Weld	No. of Passes	DCRP, Amp.*	Arc, v.	Gas Flow, Cu Ft per Hr	Welding Speed per Pass, In. per Min	Edge Preparation
HAND							
1/4	Butt	1	375	27	40–50	24	60-deg double vee, sharp nose
		2	430	28	40–50	....	....
5/16	Butt	1	400	27	40–50	20	60-deg double vee, sharp nose
		2	420	28	40–50	....	....
5/16	Fillet	1	400	27	40–50	16	Nonpositioned
1/2	Butt	1	400	28	40–50	14	90-deg double vee, sharp nose
		2	450	28	40–50	....	....
1/2	Fillet	1	450	28	40–50	12	Positioned
3/4	Butt	1	400–450	27–28	40–50	12	90-deg double vee, sharp nose
		2	450	28	40–50	....	....
		3	450	28	40–50	....	....
		4	450	28	40–50	....	....
3/4	Fillet	1	450–500	29–30	40–50	9	Positioned
1	Fillet	4†	450	27–29	40–50	7	....
MACHINE							
1/16	Butt	1	300	24	50	40	Square butt
1/8	Butt	1	380	25	50	30	Square butt
3/32	Lap	1	380	26	50	55	Positioned
5/16	Butt	1	440	26	50	24	60-deg double vee, sharp nose
		2	460	26	50	24	....
1/2	Butt	1	440	26	50	15	60-deg double vee, sharp nose
		2	460	26	50	15	....
3/4	Butt	1	400	26	50	15	60-deg double vee, sharp nose
		2	400	26	50	15	....
		3	430	26	50	15	....
		4	430	26	50	15	....

** For lower currents in hand welding back-chip double-vee welds and increase number of passes on 1/2 in. and thicker.*
† All stringer beads.



This potential use of blow molding for soft drink dispensers demonstrates the complicated shapes that can be successfully made. (By Carl Sundberg, Hercules Powder Co.)

Thin Hollow Plastic Shapes Produced by Automatic Blow Molding

by J. H. Du BOIS, Plax Corp.

A number of techniques have been developed expanding the scope of this unique plastic forming method to meet industrial needs and to produce more difficult shapes.

● MODERN BLOW MOLDING techniques for plastics enable the engineer, in many instances, to plan to mold the impossible. Shapes which cannot be molded—at least economically—by conventional methods, often adapt themselves readily to the blow-molding process.

The molding of hollow articles using fluid pressure is not new. It was, in fact, one of the earliest means of fabricating plastics. A variety of toys and novelties were formerly produced by an indirect method of blow molding. However, it involved a long and comparatively expensive cycle with scrap sheet ranging up to 50%, and one which inevitably yielded to the economic advantages of injection molding. Today, the blowing process in a new and more practical form has made its reappearance. Automatic blow molding on a modern automatic blowing machine offers the designer the mass production advantages of continuous cycle production, plus a broad range of shapes which no other molding method presently provides.

The Process

In all forms of blow molding, whether it be the indirect method first used with nitrocellulose sheeting, the diaphragm method in common use in building up certain types of laminated structures, or the direct method employed in automatic blow molding, the general sequence followed in forming the final object is similar. It involves three fundamental steps: First, the plastic must be made soft and plasticized by the application of heat or solvent. Second, it must be formed to shape and solidify against the mold. Third, it must be removed from the mold. Trimming, finishing and subsequent assembly might also be required in many cases to achieve the finished parts.

How this is achieved by automatic blow molding or the direct process is illustrated by the diagram, Fig 1, which shows the three basic steps involved in forming a Christmas tree ball using an automatic blow molding machine. In Step 1 a measured charge of material is extruded in the form of a small tube suspended between the halves of an open mold. Pressure is applied within the tube after the mold closes, as shown in Step 2, and it freezes rapidly in a thin-wall section in the mold contour when it comes in contact with the cold mold faces. In Step 3, the mold is ready to open for removal of the part.

The most familiar of current items produced by this blow-molding process is the plastic bottle. In essence, the technique is the same as that used for blowing the Christmas tree ball shown in the diagram, and the resultant part is a shape that obviously could not be achieved by conventional molding methods. Such bottles molded with polyethylene have virtually revolutionized the merchandising of many products. Their "squeeze" feature, combined with a suitable spray plug, converts the bottles into atomizers or dispensers for a variety of liquids or powders. Transparent bottles blown with cellulose acetate or other rigid materials supply ideal packaging for many dry products such as small machine parts, where the advantages of a clean, dustproof con-

tainer are of substantial importance. In all the excitement over the development of the plastic bottle, designers and engineers may have overlooked the vast potential of the blowing process for use in forming similar complicated shapes for toys, packaging and industrial needs.

Scope of Method

Many of the potentials of the blowing process are suggested by the diagram. All articles produced by automatic blow molding follow a general pattern: (1) A shape is achieved with a thin and comparatively uniform wall section having the strength features typical of spherical objects. This does not mean, however, that blow-molded shapes are limited to rounded forms. (2) Inside contours of blow-molded parts do not need to conform to the rigid limitations of injection molding. Since air, and not a steel core, forms the inner wall of the part, many problems involved in part removal are eliminated. (3) Parts with re-entrant curves which, if injection molded might involve several sections requiring subsequent assembly, can be formed in one piece, thus saving time, equipment, and at the same time yielding more attractive products. (4) If desired, air pressure can be sealed in the molding, as is the case when Christmas tree balls are formed. Such compressed air furnishes added support to a thin-wall section, permitting the manufacture of durable parts with a minimum of material. (5) Since blow molding involves comparatively low pressures, cheaper mold construction with aluminum cavities makes possible lower tool costs.

The range of wall thickness in automatic blow molding runs from a thin envelope of material barely 1/64 in. thick sections with a full ¼-in. wall. Size ranges from small 10-ml cosmetic vials to 13-gal carboys. Both design and the plastic material being molded contribute to the flexibility or rigidity of the part. Polyethylene, for example, although far more rigid when blown in the form of a large acid carboy than it is in a small "squeeze bottle", still does not have the rigidity even with a ¼-in. wall section of a comparatively thin-wall part blown with one of the cellulosic materials. Generally speaking, a structural shape with square sections is far more rigid than are round shapes. When it is desired to provide additional flexibility using one of the fairly rigid plastics, accordion-like sections will supply a reasonable amount of flexure.

Illustration No. 1

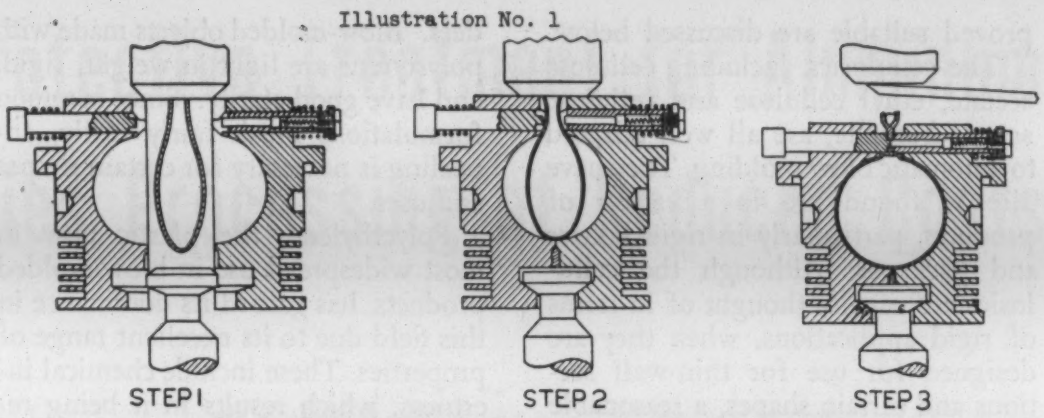


Fig 1—Typical cycle in the automatic blowing process.

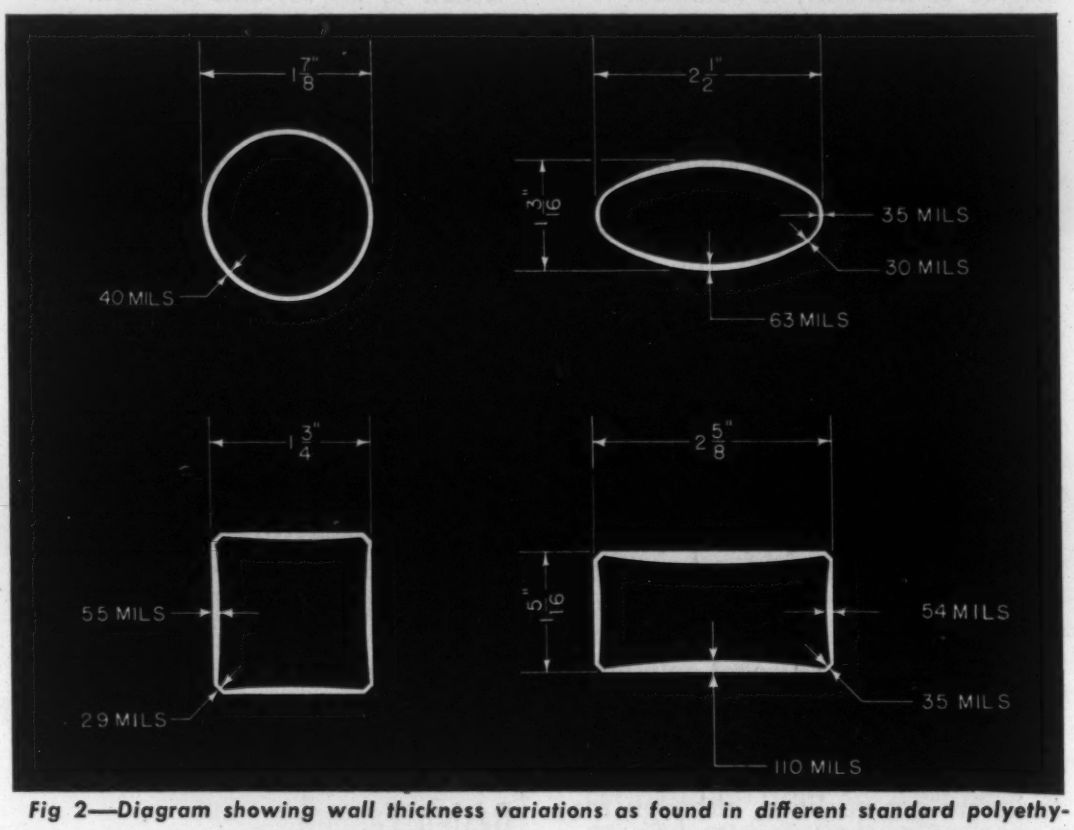


Fig 2—Diagram showing wall thickness variations as found in different standard polyethylene bottle types. All bottles shown are of comparable weight and capacity.

On equipment for small size bottles, the maximum dimensions that can be blown are: width, 10 in.; depth, 9 in.; length, 18 in. Because of insufficient operational data or experience, it is not known whether a bottle blown to these dimensions would be usable. With the equipment now available, the maximum weight obtainable is 2½ to 3 lb. This means that any bottle blown to the above dimensions might have a wall as thin as 0.030 in. There is no information yet as to the maximum size that can be blown on the 13-gal equipment other than the 13-gal bottle which measures approximately 14 in. in dia and 31¾ in. high.

Materials Adaptable

At this time, automatic blow molding is confined to the thermoplastic materials. Materials which have

Unbreakable blow-molded polyethylene bottles of 1- and 2-gal capacity suitable for chemicals, pharmaceuticals, and other liquids.

proved suitable are discussed below.

The cellulosics, including cellulose acetate, ethyl cellulose and cellulose acetate butyrate, are all well adapted to automatic blow molding. They have already found use in a variety of products, particularly in rigid bottles and packages. Although the cellulosics are usually thought of in terms of rigid applications, when they are designed for use for thin-wall sections and certain shapes, a reasonable degree of flexibility is obtained.

Color ranges in this material include water-clear transparents and a full range of opaques. However, there is a tendency for transparents to discolor with age and absorb stains from colored solutions. Important properties of cellulose acetate that make it well qualified for certain types of use are its resistance to aliphatic hydrocarbons, such as kerosene and cigarette lighter fluid, and its resistance to kitchen greases, essential oils, and citrus fruit acids. It is not suited for packaging water or alcohol-based liquids.

Acetate butyrate provides properties similar to acetate, but has a less pleasing ador. It produces somewhat tougher parts, is good for oils, but poor for water or alcohol solutions. Ethyl cellulose, with its greater resistance to moisture, provides a material for many applications where the cellulosics are not qualified, although for bottles it should be used only as a container for nonhygroscopic powders. Blow-molded objects made with polystyrene are light in weight, rigid, and have good clarity. Since common formulations break fairly easily, annealing is necessary for certain shapes and uses.

Polyethylene, the plastic now in most widespread use in blow-molded products, has gained its dominance in this field due to its excellent range of properties. These include chemical inertness, which results in it being resistant to all solvents at room temperature, and the toughness and extreme flexibility which led to the development of the "squeeze bottle" now in widespread use. Polyethylene packages can be used over a wide temperature range, although they cannot be recommended for parts which will be submitted for any great length of time to temperatures above 165 F. Kerosene, carbon tetrachloride, turpentine, cigarette lighter fluid, and diethyl ether are among the liquids for which polyethylene is not recommended as a packaging material.

Styrene-isobutylene copolymers, polyisobutylene-polyethylene mixtures, nylon, trifluorochloro-ethylene polymers, and the various vinyl chloride-based materials are among other plastics which are considered as potentially suited to the automatic blow-molding process.

Design Factors

As was noted earlier, part design plays an important role in the strength and rigidity of blow-molded objects. Since bottles of various sizes and shapes far outnumber any other type of blow-molded application up to this time, a review of some of the factors involved in their design and manufacture will serve to illustrate some of the fundamental problems encountered in the process.

From a production standpoint, the ideal bottle shape is cylindrical. The blowing process begins with the extrusion of a round tube or parison, as shown in Step 1, Fig 1, which when blown into a round bottle gives excellent distribution of the material in the bottled wall. When a square bottle is blown, the flat side walls (closest to the initial parison) tend to be thick when compared to the far corners (farthest from the parison). See Fig 2. Similarly, oval or rectangular bottles tend to have greater wall thickness on the "long" side than on the "short" side. However, as cited earlier, the additional rigidity provided by a square shape will in most instances tend to offset the disadvantage of a nonuniform wall thickness.

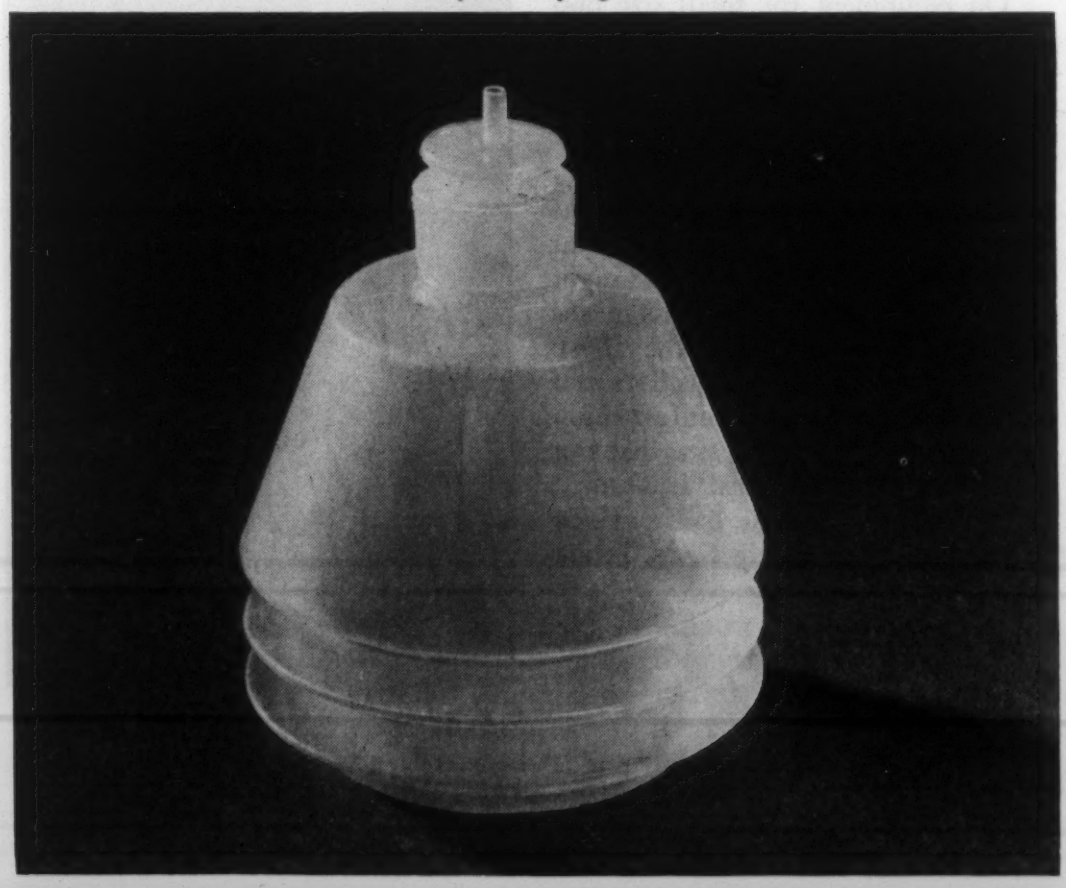
Due to this variation in thickness caused in the blowing of a round parison into an oval or rectangular shape, there is a practical upper limit to the blowable ratio of bottle length to bottle thickness. Whenever possible this ratio is held down to 2:1. However, bottles are now produced with ratios as high as 2.4:1.

Sharp corners and shoulders can be blown, but should be avoided if possible. It is more difficult to "fill out" such areas, and the tendency for thin sections is greater. Designs with severe undercuts are also apt to be difficult to blow.

A number of techniques have been developed to meet specific design problems and broaden the range of the blow-molding process. Lengthening cycles will often make it possible to achieve especially difficult shapes, though the rejection rate may run high.

A study of the current blow-molded applications illustrated here will give a good idea of the adaptability of the process to a variety of needs. A new and exciting range of shapes achievable at comparatively low cost increases the versatility and application area of all existing materials which adapt themselves to the blowing method. As development continues, other plastics, which at present do not lend themselves readily to blowing, should certainly find a place in the product picture.

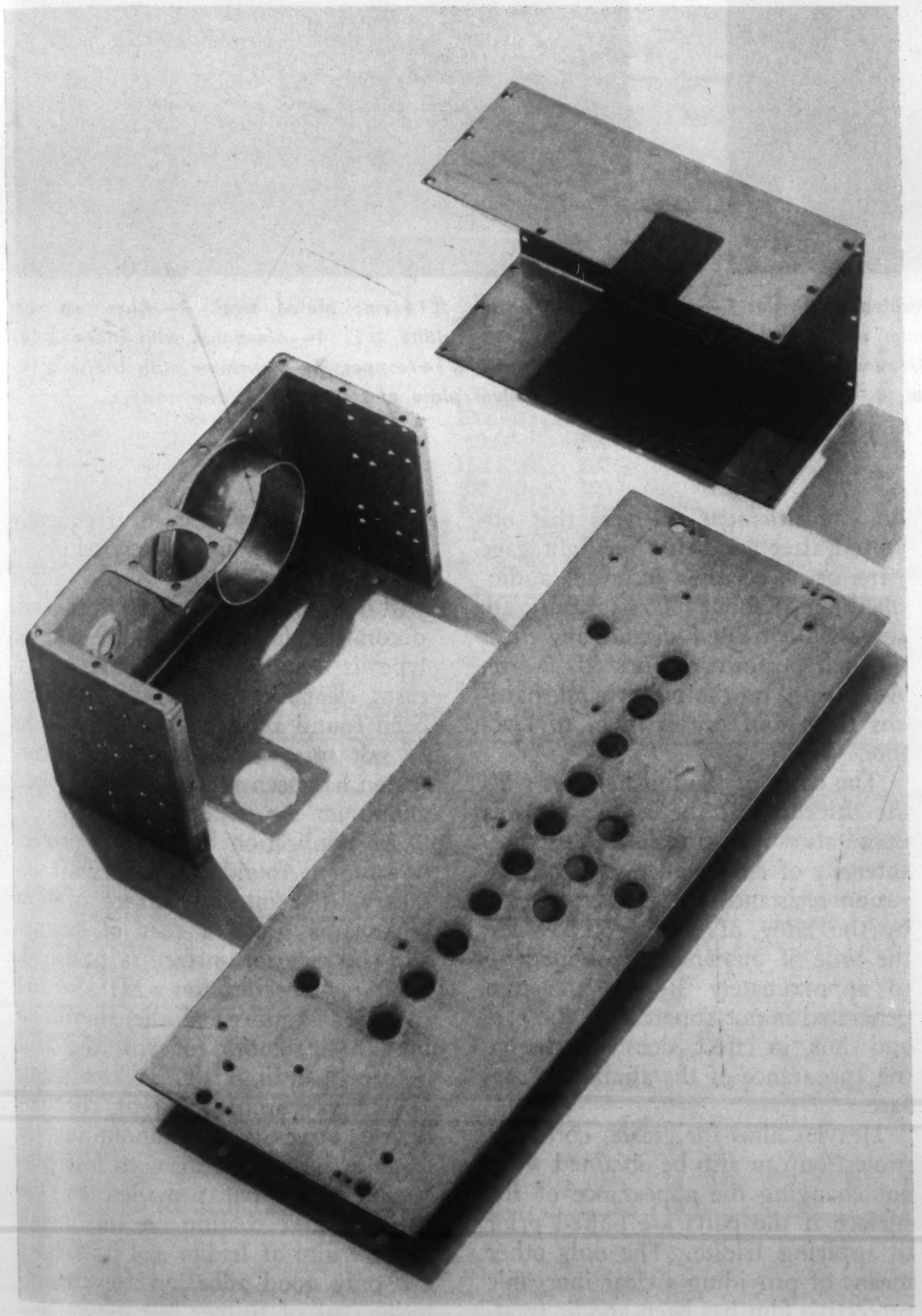
A collapsing accordian-type design which provides flexibility when the material itself is comparatively rigid.



New Protective Treatment for Aluminum Simplifies Processing at Reduced Costs

by R. STRICKLEN, Development Engineer, Allied Research Products, Inc.

The chromate film produced by this method is an integral part of the metal itself and, therefore, provides excellent corrosion resistance and, if desired, can also serve as a paint base.



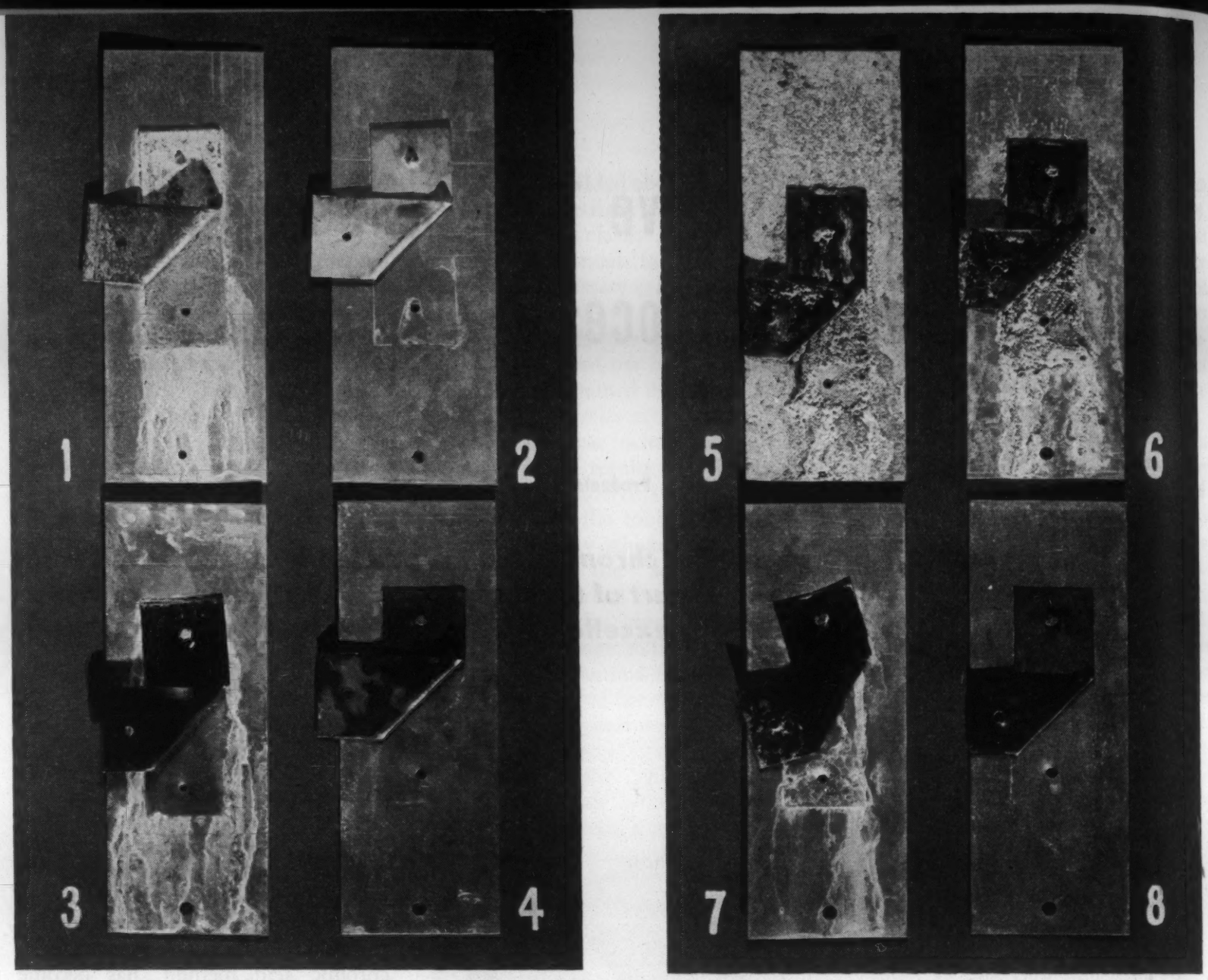
Typical aluminum parts treated with Iridite #14.

● ALUMINUM, LIKE OTHER metals, requires a treatment to prevent its oxidation, particularly when used in alloy form. Also, treatment prior to painting is essential to make the paint stick and to prevent penetration of moisture through the pores in the paint. Anodizing by the electrolytic sulfuric acid method, or electrolytic chromic acid method, has become recognized as the most effective protective treatment for aluminum, but it requires processing periods ranging up to about 30 min. Some chemical dip processes have been developed and marketed to short-cut processing time, or to eliminate the use of electrolysis. However, their practical use has been limited to service principally as a base for paint. These chemical processes range around 15-min duration at temperatures up to boiling point and are applied in two steps.

World War II established the merits of chromates on zinc and cadmium. More recently, Allied Research Products, Inc. developed a chromate process for aluminum known as Iridite #14 (Al-Coat), which has proved to have many desirable characteristics. It has been tested and accepted in government specifications work. Industry is rapidly substituting its use for electrolytic anodizing wherever possible because of its simple, short-cut methods of application and because of its effectiveness as a protective treatment for aluminum and its alloys.

General Properties

Unlike anodizing and certain chemical treatments, the Iridite film



Effect of galvanic corrosion on treated and untreated aluminum: 1—Aluminum with Iridite #14/zinc plated steel. 2—Aluminum with Iridite #14/cadmium plated steel. 3—Aluminum with Iridite #14/zinc plated steel with Iridite #1. 4—Aluminum with Iridite #14/cadmium plated steel with Iridite #1. 5—Aluminum/copper. 6—Aluminum with Iridite #14/copper. 7—Aluminum with Iridite #14/zinc plate and Iridite #1 over copper. 8—Aluminum with Iridite #14/cadmium plate and Iridite #1 over copper.

is not an oxide, and unlike other types of chemical treatments, it is not a phosphate. The Iridite film is of a complex chromium-chromate nature. It is generated by a reaction which occurs when the aluminum part is immersed in the Iridite solution. Thus, it is an integral part of the metal itself, rather than a superimposed film such as paint. However, the amount of aluminum that enters into the reaction is so slight that the dimensional stability of even the most closely machined surface is not affected. It is estimated that the full thickness of the Iridite film is in the order of 0.00001 in.

The chromate film is amorphous and nonporous. It is somewhat harder than the chromates on zinc and cadmium, but does not have the hardness of aluminum oxide. However, it will resist abrasion, providing the abrasion is not of a cutting nature. It will also withstand cold forming operations but cannot resist wear to the same degree as aluminum oxide.

Treatment with Iridite produces no embrittlement, such as that observed after anodizing on light gage wire or sheet. For instance, audio-diaphragms about 0.003 in. thick are successfully treated without any effect on their performance or fatigue life. Anodizing, on the other hand, hardens them and causes them to fracture.

The color of the finish varies with the thickness of the Iridite film, as does also its corrosion resistance. Intensity of color and degree of corrosion resistance are further affected by the alloy of the metal. When the time of immersion is limited up to approximately 30 sec, the film generated is not apparent to the eye, and thus, in effect, does not change the appearance of the aluminum surface.

Heavier films for greater corrosion protection can also be obtained without changing the appearance of the surface if the parts are buffed prior to applying Iridite. The only other means of providing a clear inorganic protective film has been anodic treatment. In the case of die castings, a high silicon content is frequently necessary to obtain the desired physical properties. High silicon alloys will not take clear anodic films; thus, decorative finishing of the anodic type is impossible. In many such cases, clear films of Iridite #14 have been found applicable. Up to 56 hr of salt spray before first white corrosion has been reported on polished aluminum die castings.

An application for a clear protective film is found in the aircraft industry. The interior surface of skin sections is given a coat of primer and the exterior surface is polished. Military specification MIL-S-5002 calls for treatment of the aluminum in a 5% solution of chromic acid before painting. This treatment, known as chromatizing or chromodizing, leaves the aluminum surface in an active condition, with less protection than that provided by the natural oxide coating on the metal. A clear film of Iridite #14 provides not only good adhesion for the interior coat of primer but measurable protection for the exterior as well.

Immersion in the Iridite solution for a longer time than that which produces the clear coatings (30 sec) yields a heavier film that reflects a yellow color. This film becomes more evident as the immersion time increases from 30 sec up to as long as 2 min. There is little variation of color among wrought alloys. The surface of die cast alloys containing high copper and silicon generally takes on a lighter color for a given immersion time than low copper and silicon alloys. However, ground or machined areas of such parts color about as rapidly as wrought alloys.

It has also been shown in the laboratories that the yellow Iridite film can be dyed various colors. However, it is anticipated that when the coloring technique is released to industry, it will be used substantially for parts identification rather than for decorative finishing, such as is obtainable with dyed sulfuric acid anodized surfaces. Due to the iridescent nature of the yellow Iridite film, the dyed surfaces are not uniform in texture or intensity. The work is limited to organic dyes and, consequently, will fade upon constant exposure to sunlight, as will the anodized colors.

Corrosion Resistance

This chromate treatment has proved beneficial on all aluminum alloys and forms tested, including work hardening and heat treatable alloys in rolled, drawn, extruded, sand cast, permanent mold cast and die cast shapes. The number of hours in salt spray to first signs of white corrosion varies in the same order as the inherent resistance of the alloy itself to salt spray attack. In general, the salt spray resistance is inversely proportional to the copper content of the alloy. High copper alloys, 5 to 10% copper, show first signs of breakdown in 50- to 200-hr salt spray. Alloys with medium copper content, 3.5 to 5%, withstand 200- to 300-hr exposure. Alloys containing copper only as an impurity show first signs of white corrosion in 250 to 1000 hr. These figures in Table 1 are representative of production experience with the yellow coating.

The yellow film, formed by a 2-min treatment, on 24S-T3 aluminum is approximately equal in protective value to anodic films resulting from 20-min treatment in sulfuric acid or 30 min in chromic acid.

Clear films can generally be classified as giving a salt spray resistance on the order of 25% of that obtainable with the yellow coating on any given alloy. However, this can be varied by the degree of mechanical or chemical polish on the metal surface before the application of Iridite. In addition to the yellow film, the clear treatment has been accepted in government specification on order MIL-C-5541, but is not recommended generally by the manufacturer for specification work where corrosion resistance is of prime importance.

Some work has been done on evaluating resistance to corrosion caused by various mild alkali, including various soaps and detergents. Table 2 illustrates results after 750-hr immersion in the solutions listed.

Some work has also been done to evaluate the contribution Iridite might make to help minimize the effects of galvanic corrosion. This study has proved Iridite to be of some value and indicates measurable advantages. It will be interesting to note that in these salt spray tests, cadmium plus Iridite #1 and aluminum plus Iridite #14 afforded the best combination of treatments for the various metals brought into couples.

In a corrosive medium, galvanic attack on the aluminum occurs at any junction with a cathodic metal such as copper, brass or steel. An accompanying photograph compares the effect of salt spray on unprotected aluminum in contact with various cathodic metals and the effect of protecting the aluminum only with an Iridite film.

A further gain in protection is realized when the difference in potential

Table 1—Results of Salt Spray Test

Alloy	Form	Hours to First Signs W/C		Hours to Breakdown	
		Min	Max	Min	Max
2S	Panel	250	500	600	800
3S	Panel	250	500	600	800
11S	Machined Bolts	150	300	400	500
17S	Machined Knobs	200	250	500	700
24S	Panel	200	300	400	600
52S	Panel	400	900	1000	1300
53S	Screen	600	1000	1200	1400
13	Die Cast Flange	100	175	300	500
43	Die Cast Kettle Spout	100	175	200	400
122*	P.M. Cast Test Bars	50	100	200	400
142*	P.M. Cast Test Bars	150	200	300	500
218	Die Cast Box	200	300	600	800
380	Die Cast Piston	100	175	300	500
75S	Panel	200	300	400	600
78S	Panel	200	300	400	600

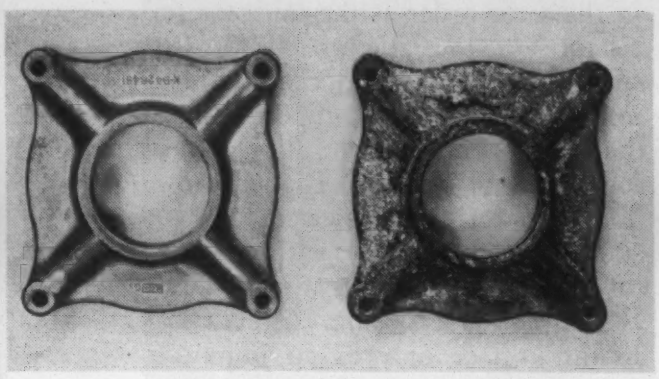
** Machined areas on these castings break down much more rapidly than original casting skin.*

Table 2—Resistance to Mild Alkalies

Test	pH	Die Castings #13 and #380		Sheet Stock—3S Alloy		
		Iridite Yellow	No Treatment	Iridite Yellow	Iridite Clear	No Treatment
Na_3PO_4	10	N.C.	G.C.	N.C.	G.T.	G.T.
Na_2CO_3	10	N.C.	G.C.	N.C.	S.T.	G.T.
Ivory Soap	10	N.C.	S.C.	N.C.	T.	S.P.P.
Fels Naphtha	10	N.C.	S.C.	N.C.	N.C.	N.C.
Tide	10	N.C.	P.P.	N.C.	N.C.	N.C.
Fab	9.8	N.C.	P.P.	N.C.	N.C.	N.C.
Dreft	7.9	S.P.P.	G.P.P.	N.C.	N.C.	T.
Special (1)	11.7	N.C.	N.C.	N.C.	N.C.	N.C.
Special (2)	12.0	G.E.	G.E.	S.E.	S.E.	G.E.

Abbreviations above denote:

N.C.—No corrosion
G.C.—General corrosion
S.C.—Slight corrosion
S.T.—Slight tarnish
G.T.—General tarnish
T. —Tarnish
P.P. —Pin point
G.P.P.—General pin point
S.P.P.—Slight pin point
G.E. —General etching
S.E. —Slight etching



These die castings of aluminum alloy #13 were subjected to a 168-hr salt spray test. Casting at left was given the new protective treatment; casting on right had no treatment.

between the two metals is reduced by zinc or cadmium plating the cathodic metal, and by further protecting the plate with an appropriate Iridite film.

It appears that Iridite also affords effective corrosion protection to abraded areas. This was first noted on salt spray specimens which had been bent in a machine break after treatment and before salt spray exposure. The surface was scratched by irregularities in the forming tools, and after 216 hr in salt spray no corrosion was apparent in the scratches. This property was investigated further by salt spray exposure of Iridited panels along with anodized panels. After treatment, the panels were machine cut to a depth of 0.003 to 0.005 in. and varying in width up to 1/8 in. The so-called scratched areas on the chromic acid anodized panels corroded much more in salt spray. The explanation for this phenomenon is that Iridite possesses sufficient leaching qualities so that scratched areas are protected by the adjacent remaining film.

Paint Base

Chromates provide their paint adhesion through an intimacy of contact, usually referred to as molecular adhesion. This is also the same way that sealed anodizing affords its adhesion. Initial adhesion is important only in that it causes the paint to adhere to the surface immediately upon application. Table 3 shows that Iridite #14 compares favorably with mechanical methods of adhesion in this respect.

Lasting paint adhesion is far more important. All paints have pores through which moisture will penetrate to the metallic surface. Upon reaching the aluminum surface, the moisture or corrosive atmosphere causes the formation of metallic soaps which raise the paint film. Iridite, however, provides a barrier against this moisture penetration. Even if the paint surface is scratched, corrosion adjacent to the scratch is retarded.

Electrical Properties

Compared to anodic films, Iridite #14 films have an extremely low electrical resistance to direct current and to low and high frequency alternating current. This is of considerable advantage in electronics. Protection can be applied to chassis shields, mounting brackets, wave guides, connector plugs, etc., without interfering with the electrical characteristics or ground connections. Table 4 shows some direct current measurements. Even though the resistance is several times that of clean aluminum, it is reported that 500,000 microhms is a satisfactory ground resistance and Iridited aluminum is well within this figure.

In addition, the treatment offers a simplified means of eliminating RF interference by providing corrosion resistance directly on the aluminum surface; thus, the need for electroplating and subsequent treatment of the plated surface is eliminated.

In high frequency applications of aluminum it has been found that no practical difference results in the circuit from the use of Iridite. For instance, for the "S" band range of 2600 to 3950 MCPS, the standard allowable attenuation range for clean aluminum with an RG-75/U wave guide section is 0.0064 to 0.0094 Db/ft. Iridited aluminum fell well within this range with an attenuation of 0.0084 Db/ft.

Weldability

It is claimed by various aircraft manufacturers that Iridite apparently produces a fluxing effect in shielded arc welding. This may be due to the fact that the treated surface ahead of the weld does not oxidize. All specimens of varying alloys and conditions show perfect penetration and complete freedom from contamination.

Where it was formerly necessary to clean the sheets and weld shortly thereafter, it is now possible to store treated sheet and weld the sheet as it comes from stock. Also, treating the sheet with Iridite permits smaller processing tanks than would be needed if the finish were applied to completed assemblies.

With regard to spot welding, only the clear Iridite treated aluminum lends itself to commercial welding. However, it has been reported in some cases that the yellow film treatment has been successfully spot welded. Little is known about solderability of Iridited aluminum; present indications are that it can be done.

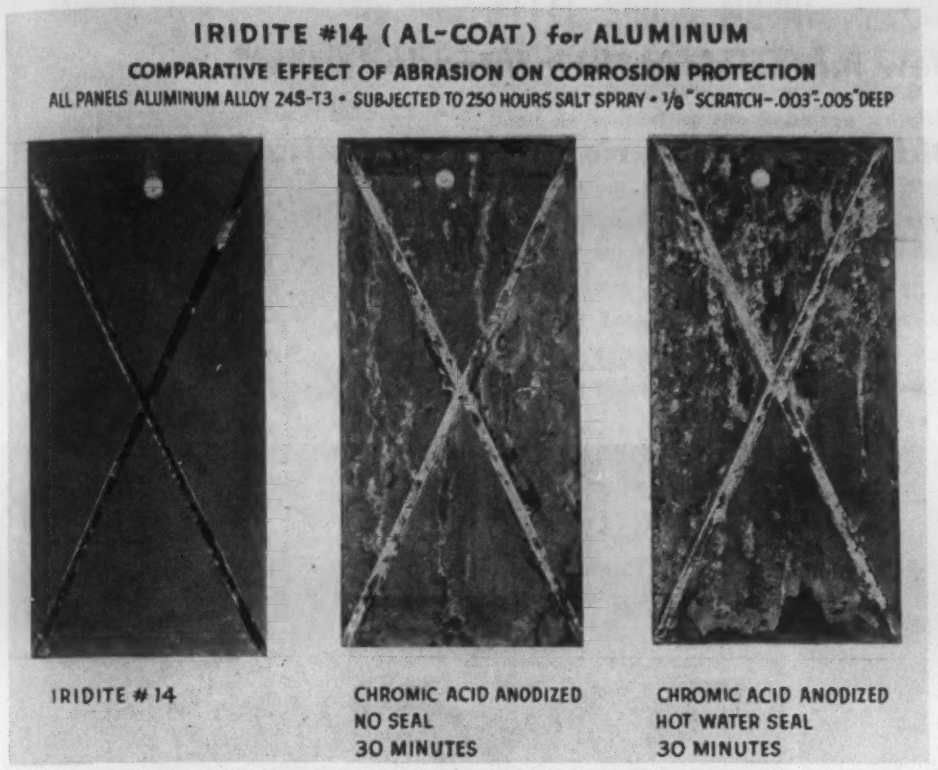
Table 3—Paint Adhesion

(One Coat Air Dry Lacquer, Bell Laboratories Adhesion Tester)

Surface Treatment	Max Load in Gm without Flaking	
	3S	24ST
Chromic Acid Anodizing	3500	5000
Phosphoric Acid	4500	2250
Caustic Etch Plus Nitric Acid	3750	5000
Iridite #14	5000	5000

Table 4—Electric Properties

Treatment	Electrical Resistance	
	10-Psi Pressure	100-Psi Pressure
Cleaned Aluminum	1500 microhms	500 microhms
Aluminum plus Iridite #14	8000 microhms	1900 microhms
Aluminum plus Anodizing	Over 88 ohms	Over 88 ohms



Comparative effect of abrasion on corrosion protection of 24S-T3 aluminum alloy. Panels with 1/8-in. scratch, 0.003 to 0.005 in. deep subjected to 250-hr salt spray.

Applying the Finish

Cleaning—The preparation methods used for this acid chromate process are conventional and are selected after consideration of the alloy composition, the type and extent of the surface contamination, and the end result desired. Pre-cleaning, where necessitated by large quantities of greases, oils, drawing and cutting compounds, etc., may be accomplished by solvent vapor or emulsion degreasing. Final removal of traces of organic material is accomplished by alkali soak cleaning. If etching is desired, formulations based on sodium hydroxide, sodium carbonate and/or tri-sodium phosphate can be used. If no etching is permitted, any of a number of proprietary inhibited alkaline cleaners will be found satisfactory.

If an etch type alkali cleaner is used, a slight smut will be formed on all types of aluminum except those of high purity. It consists of alloying constituents insoluble in the cleaning solution. If an inhibited cleaner is used, natural oxides or oxides from heat treating operations remain on the surface. The smuts or oxides are removed most thoroughly and economically by certain proprietary acid chromate formulations which are generally sold as a preparation for spotwelding. These deoxidizers are used in water solution at room temperature. Immersion of the work from 30 sec to 5 min usually suffices for producing a chemically clean surface. Thorough rinsing should follow both the alkali and the acid cleaning steps. When high silicon alloys are etched, mixed hydrofluoric and nitric acids are required to remove the smut.

Where space limitations or economic considerations prohibit the installation of the recommended cleaning cycle, a one-stage method is used, but at some sacrifice in the cleaning speed and degree of corrosion protection.

The Solution—The concentration of the Iridite solution depends upon whether it is to be applied by spraying, dipping, flow-coating or brushing. Other factors in solution concentration are the time cycles available for the various methods of application and whether a clear or yellow film is required. Parts can be processed as piece parts or in bulk in conventional manner.

A typical dip solution is made up as follows:

Iridite #14	3 oz per gal of solution
Temperature	75 to 95 F
pH	1.5 to 1.7
Time	10 sec to 5 min

The optimum time of immersion for a clear treatment is 10 to 30 sec; the optimum time for the yellow coating is 2 min. On some few alloys, additional protection can be obtained by extending the time of immersion up to 3 to 5 min.

In some applications, immersion times of only 10 to 30 sec may be impractical from the standpoint of material handling. In such cases the time for forming clear coatings can be extended by reducing the concentration of the Iridite #14 powder to 1.5 oz per gal of solution and by raising the operating pH to approximately 2.2.

For typical spray application, the solution is operated at 1.5 oz per gal of solution and a pH of 1.8 to 2.0. A protective film is obtained in 10 to 30 sec. Conventional stainless steel spraying equipment is satisfactory. Brush or flow coat application is used either on assemblies too large for tank immersion or for touching up on small areas. The normal 3-oz-per-gal concentration is used after adequate chemical or mechanical cleaning.

The solution is controlled by a simple titration to determine if the solution is within the range of effective concentration. Periodic electrometric pH measurements are required to maintain uniform activity. When the concentration of the solution is correct and further pH reductions are necessary, this can be accomplished by the addition of small quantities of nitric acid.

Due to its low operating temperature and broad range, the solution seldom needs heating or cooling. No fumes or spray are given off. Consequently, no ventilation is required. Agitation of the work, beyond that necessary to insure complete coverage of all surfaces, is neither required nor recommended. However, when agitation is inherent in the treating equipment, such as in spraying, the effect is compensated for by pH adjustments.

Conventional drying methods are used to remove the rinse water from the part. Usually after a dip in a hot rinse, hot air will assist in more rapid evaporation of the water. Centrifugal drying is quite advantageous in bulk processing.

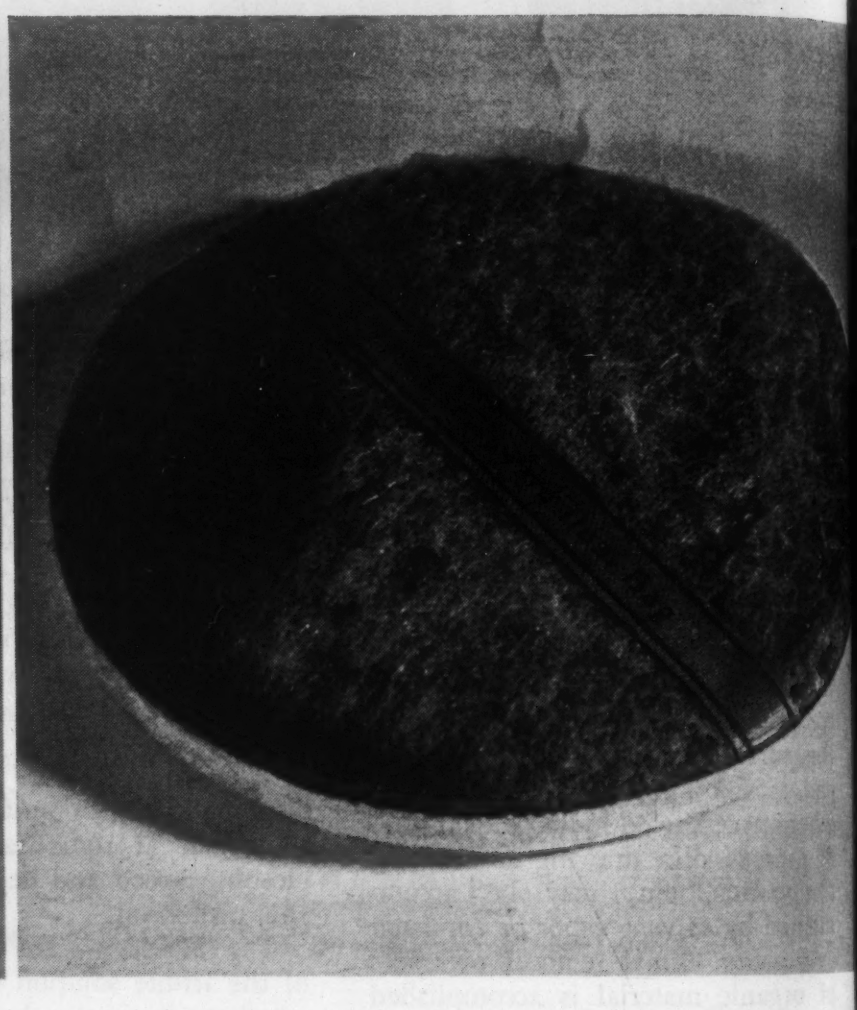
In conclusion, it should be stated that much is yet to be learned about the characteristics of this Iridite treatment. Many applications are developing from the use of this treatment in industry. The latest development, about which little is as yet known, is that the Naval Research Laboratory has discovered Iridite #14 affords a better bond for rubber than does anodizing. However, further evaluation must be made to intelligently guide usage in this manner. At the present time, though, this application has passed the experimental stage and is being used in regular production.

Materials at Work

Here is materials engineering in action . . .

New materials in their intended uses . . .

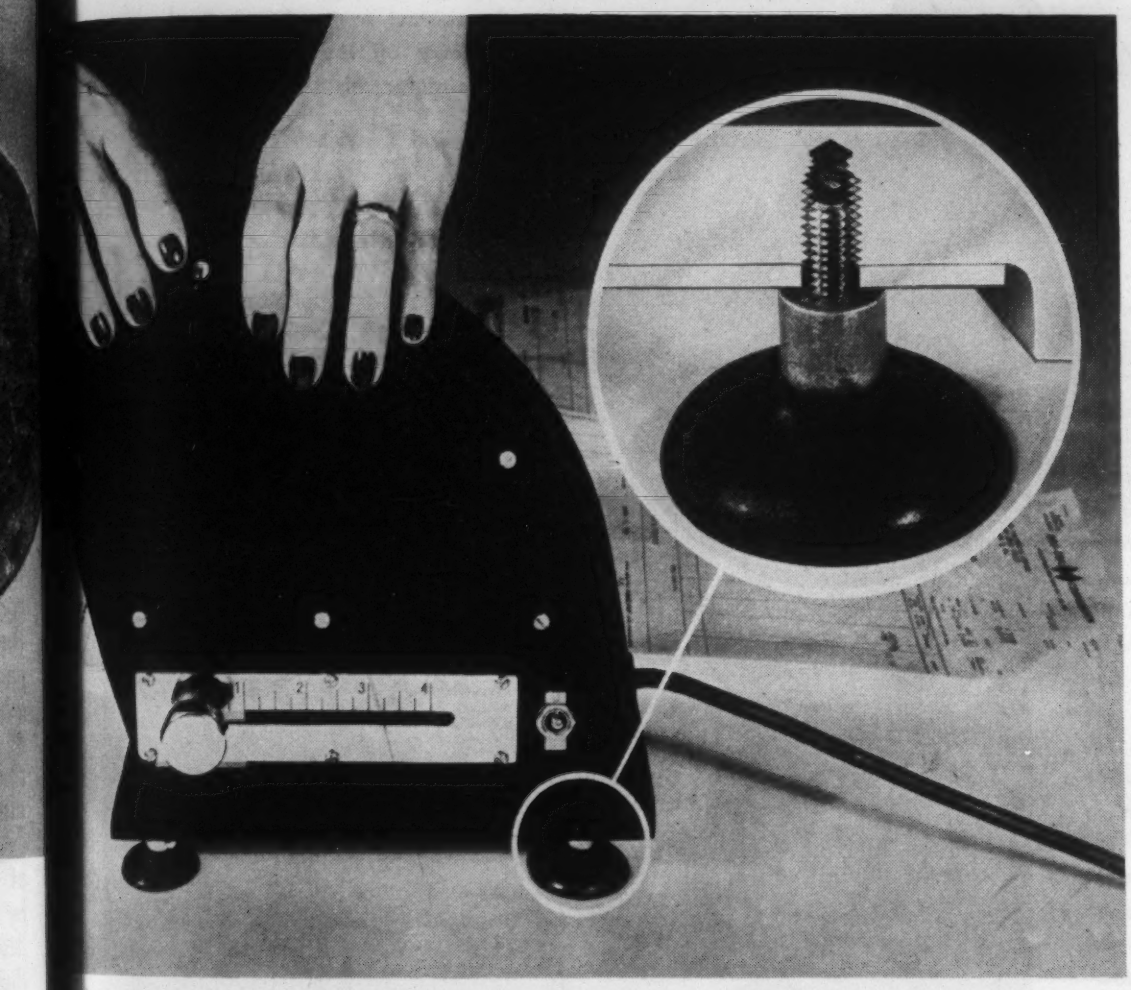
Older, basic materials in new applications . . .



FELT IN VACUUM CLEANER *Two types of felt are used by the makers of the Electrolux cleaner and air purifier filter and pad. The filter felt is specially designed for minimum air resistance and structural strength. It is installed at the exhaust end of the cleaner, and must pass all the air that goes through the cleaner. The felt does not clog quickly, and offers ten times as much dust retention as cloth. The filter also reduces noise. The pad felt, much more dense than the filter felt, is used under the lamb's wool buffer of the air-driven polishing attachment available for the Electrolux. It provides a flexible backing for the buffer and also has sufficient friction with the buffer to prevent slipping. For quick assembly in the Electrolux plant, both filter and pad felts are supplied cut to accurate dimensions. The felt for both the filter and the pad was supplied by the American Felt Co., of Glenville, Conn.*

METAL SHOCK MOUNT

A number of conflicting problems have always been associated with the design of instrument mounts. If possible, they should cushion shocks, and isolate vibration as well. Aging set is also a headache. The Met-L-Flex mount has been developed by the Robinson Aviation Co. of Teterboro, N. J., to meet these challenges. A wire mesh cushion and spring do the job. Various types use monel and Inconel mesh woven from wire produced by the Driver-Harris Co., of Harrision, N. J. The wire mesh does not age like nonmetallic materials, and can be counted on to operate under all weather conditions and at temperatures as high as 300C, with Inconel spring and mesh woven from fine Inconel wire. For sudden severe shocks, Met-L-Flex mounts use an auxiliary cushion of monel mesh, chosen not only for monel's resistance to corrosion but also for its toughness and ductility. For marine instrument applications, Robinson Aviation Co. is supplying the mounts made entirely of monel.

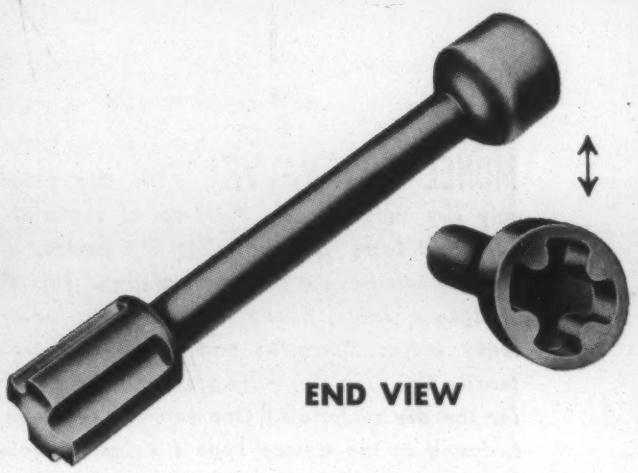


HELICAL THREAD INSERTS IN ALUMINUM CASTING

Because helical-wire thread inserts substantially increase the loading strengths of threads in light-metals, and thereby lessen stripping possibilities, the Staplex Co., of Brooklyn, N. Y., has specified them as original manufacturing components to solve a problem of stripped threads in its automatic stapling machines. Four rubber suction-cup legs screwed into the bases of these lightweight castings permit the machines to cling firmly to any flat surface.

On the prototype model, the four 6-32 mounting threads in the casting stripped when the machine was rocked to break the vacuum. To prevent the stripping of these threads on production models, 8-32 stainless steel Heli-Coil thread inserts are now installed in these holes. Threads in the insert-lined holes can safely withstand 20 to 30% higher loads than unprotected tapped holes because of better load distribution. The spring-like coils of these inserts automatically adjust themselves to both the receiving threads in the castings and the threads on mating parts.

Instead of the conventional 60% thread flank engagement between threaded members and receiving threads, helical-wire thread inserts provide flank engagements of about 80%. In addition to the resultant higher loading strength, the physical properties of the 18:8 steel used in the manufacture of these thread inserts are such that wear from repeated assembly and disassembly is practically negligible. Also, all possibility of corrosion, galling and seizure is claimed to be eliminated.



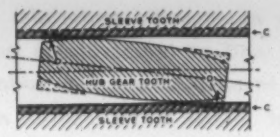
END VIEW

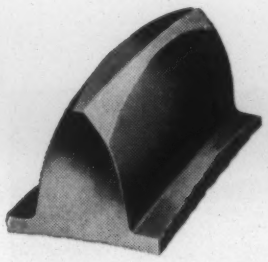
SPINDLE AND COUPLING BOX UNIT

On a rolling mill stand, the coupling boxes and spindles were wearing out at the rate of one box and one spindle each month. To replace these, a combination spindle and coupling box unit was cast by the Stroh Process, an exclusive manufacturing process of Stroh Process Steel Co. This unit gave six months of service on the same rolling mill stand. The Stroh Process involves the casting of a tough, austenitic steel alloy on a base of plain carbon steel. Since the depth, thickness, degree of hardness and location of the alloy can be controlled, it was applied only to the spindle wabblers and the pads of the coupling-box end. The alloy cannot come loose from the base metal. It does not split, crack or spall; and it will not spread or flow.

Materials at Work

FLEXIBLE COUPLING

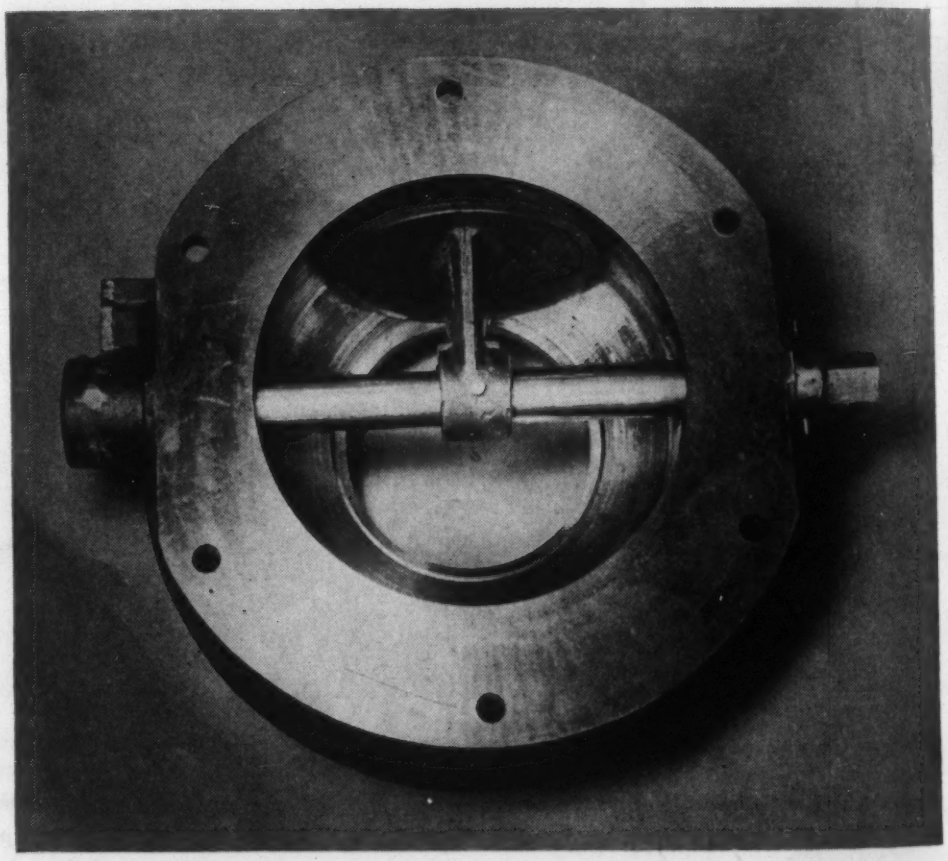


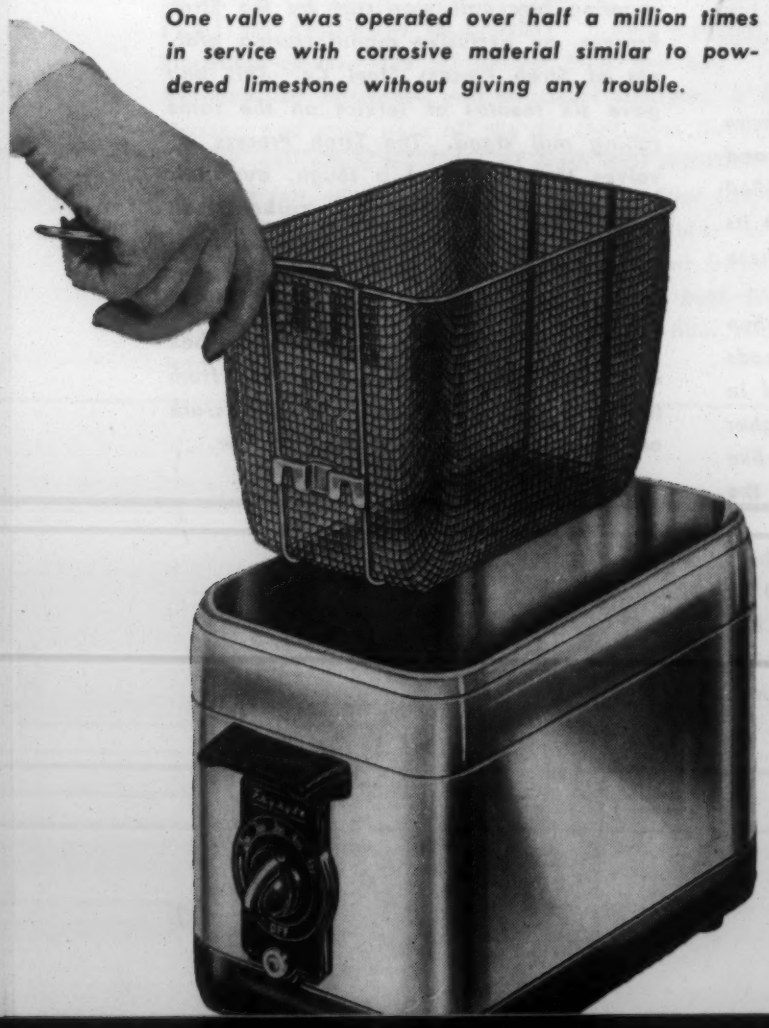


The American Flexible Coupling Co. developed a new gear tooth design for their Amerigear Couplings. The power load is distributed over a greater surface of each gear tooth than in previous models. Backlash is less and flexibility is greater. All the load is carried on the strong tooth flanks rather than on the tooth edges. To compensate for misalignment, the length of the hub teeth was increased by an amount equal to the normal clearance for standard teeth, and the tips were crowned with a radius equal to the outside radius of the gear. The crowned tip of each tooth contacts the root of the internal spline tooth in the sleeve of the coupling, piloting it with a ball and socket action. The tooth edges are also chamfered to avoid interfence with the spline tooth fillet and to transfer the contact to the broad flank of the gear tooth. The flanks carry all the load, providing for correction of lateral and angular misalignments.

MONEL DRY VALVE

The big problem in any dry valve is the build-up of material on its seat and face. Dry materials like pastes, powders and crystals have a tendency to cling. This build-up wedges a valve, finally resulting in a loose-fitting, leaky valve. Corrosive and abrasive materials intensify the problem; pitting offers an extra toe-hold for the dry materials. One solution to the problem is found in the Gemco Type T valve, manufactured by The General Machine Co. of New Jersey, Newark, N. J. Each time the Type T is opened or closed, the disk wipes across the entire seat face. Like one hand washing the other, both are cleaned in the process. Both the seat and the disk are cut on the radius to get a full cleaning action. For corrosive service, General Machine produces the valve in monel. The seat is cast S monel, the disk and valve body, cast monel. The shaft is wrought monel; the bushings are centrifugally cast monel. One valve was operated over half a million times in service with corrosive material similar to powdered limestone without giving any trouble.





AUTOMATIC FRYER

The Fryryte automatic electric deep fryer, manufactured by Dulane, Inc., is designed to operate right on the table. The fryer holds 4 lb of shortening or 4 pints of oil in the frying well. The engineered design of the aluminum cast well provides for controlled heat, and a new type, embedded heating element on three sides speeds up heating of the oils. A quarter-inch asbestos sheet and four small, molded plastic feet protect table surfaces from the heat. The temperature scale, bulb retainer, and lid and temperature control knob are all molded of Durez phenolic by the Opper Mold Tool and Die Co. The trade name, Fryryte, and the temperature readings are all molded in the larger part and then white enamel is wiped in to highlight them. At the bottom is the heat indicator light, held in place by a tiny, half-inch Durez molded part, which can be easily removed if replacements must be made. A brown, heat resistant Durez phenolic is used on the lid knob, which makes it easy to remove the cover without worrying about finger burns.

How Structure Influences the Machinability of Thin Gray Iron Castings

by **EDWARD A. LORIA**, Senior Engineer, The Carborundum Co.

Practical test results show that innoculating iron with silicon carbide improves surface machinability of thin sections.

● CASTINGS ARE USUALLY designed to require only light machining to finish to dimensions. Therefore, the cutting tool removes only the "as-cast" surface plus a shallow cut into the underlying metal. Since the microstructure of cast iron is quite sensitive to variations in rate of cooling, the outer skin of the castings has a different structure and is usually less easily machined than the interior. Because large tonnages of cast iron go into relatively thin castings, such as countless small machine components, which are machined only on the surface, it is important to know just how machinability is influenced by this skin effect.

Of the tests applied to cast iron, those which measure cutting tool life in relation to the volume of metal removed are a valuable means of evaluating machinability and appear to correlate most satisfactorily with commercial experience. Thus, a test was devised in cooperation with a leading machine tool manufacturer which would involve light surface cuts at commercial speeds on thin samples, whose thickness could be varied to give different cooling rates. In order to carry out the foundry phase of this program, a cooperative arrangement was undertaken with two large automotive foundries.

The test pieces were individually cast rings machined on the parallel faces. Since tool wear in machining a thin section is measured in the test, a large number of rings of similar chemistry were required. These rings of 7-in. i.d., 9-in. o.d., and ½-in. thickness were individually cast in core sand in order to eliminate the variable effect of moisture on the surface structure of green sand castings. The complete program required several days of commercial operation, and the ring specimens were poured from 1000- to 1200-lb. ladles of irons which were within the desired analysis range. Irons of similar chemistry and section were melted with and without the cupola addition of Ferrocarbo silicon carbide briquettes. Generally, the effect of adding these briquettes is to produce a more uniform graphite structure and to prevent the formation of "hard spots" or chill areas.

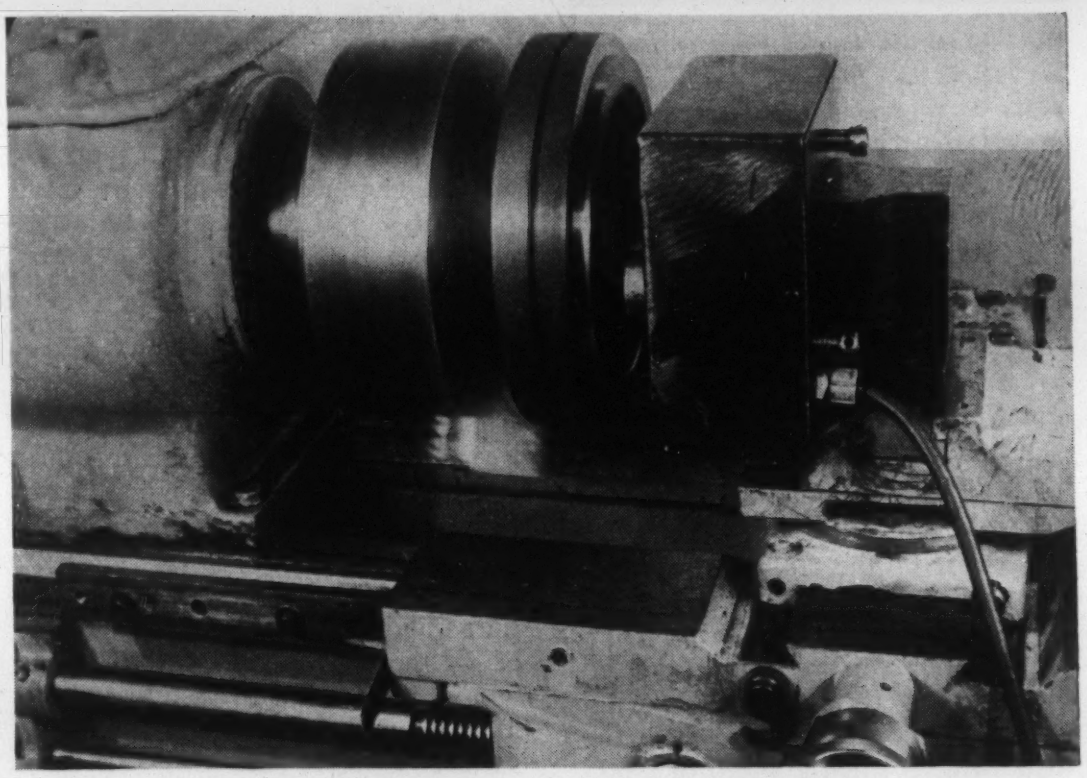


Fig 1—Cutting the inner surface of a test ring.

Machinability Tests

The machining tests on the rings were made on a 14-in. engine lathe. A 1/16-in. depth of cut was taken across the face of the ring in order to determine tool wear when operating across the "as-cast" surface or "skin" of the iron. This is the most sensitive area affecting machinability. To hold the rings, a special chuck was made which clamped them around their entire periphery. The inner and outer cylindrical surfaces of each ring were ground to give accurate control of area and smooth passage of the tool across the work face. The special chuck was carried in a three-jaw chuck attached to the spindle of the lathe. A test ring was clamped in the chuck and cuts were taken alternately on cope and drag faces with a carbide tool, as shown in Fig 1. No test ring was machined on both faces in the same test. This aided in eliminating individual differences between test rings and faces.

Single point Carboloy, grade 44A, tools were used. They were ground with back and side rake angles of 0 and 4 deg. A 30-deg by 0.025-in. chamfer on the nose was selected from practice tests and the surface roughness on the ground tool was 7 to 8 microinches as determined by

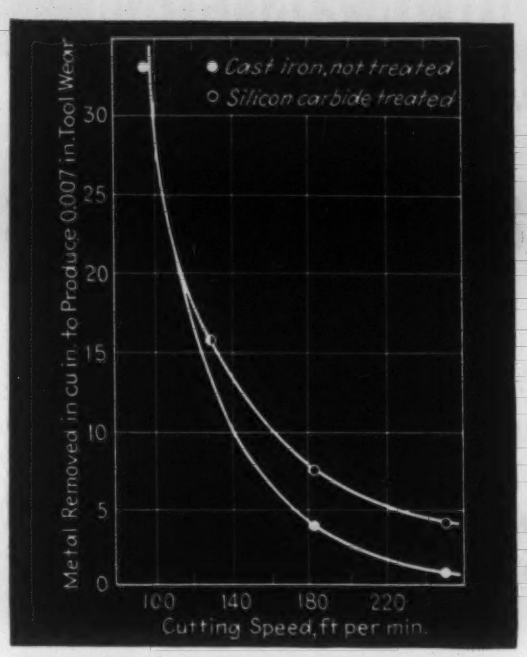


Fig 2—Tool life data obtained on machining ½-in. thick rings of cast iron at a depth of 1/16 in. below the as-cast surface. 0.007 in. wear land.

	Total C	Si	C Equiv.
Untreated iron	3.34-3.46	2.12-2.20	4.05-4.18
Si carbide treated	3.32-3.42	2.04-2.18	4.00-4.12

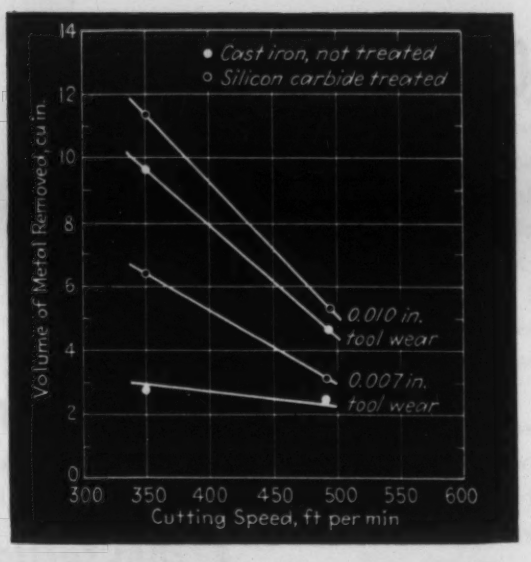


Fig 3—Tool life data obtained on machining the rings described in Fig 2 at a depth of ⅛ in. below the as-cast surface.

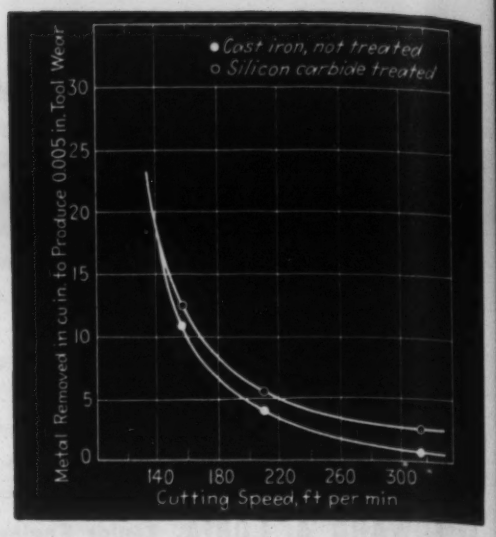


Fig 4—Tool life data obtained on machining ½-in. rings at a depth of 1/16 in. below the as-cast surface. 0.005 in. wear land.

	Total C	Si	C Equiv.
Untreated iron	3.47-3.56	1.79-2.13	4.13-4.22
Si carbide treated	3.45-3.56	1.86-2.12	4.12-4.19

a profilometer. A nominal depth of cut of 1/16 in. was used with a feed of 0.010 in. per revolution. The flank wear on the tool after each cut was measured by a 100 power microscope at a location 0.005 in. from the chamfer. This wear was expressed in terms of the volume of metal which could be removed before the wear land reached a width of 0.005 in., 0.007 in. or 0.010 in. Tests stopped at any of these values require less material and correlate well with those run to a full 0.030 in. wear land which represents complete failure for carbide tools. Although normally the latter is the limit, lower limits are often used when dimensional tolerances are extremely close. In such jobs the wear land cannot exceed 0.015 in.

Results

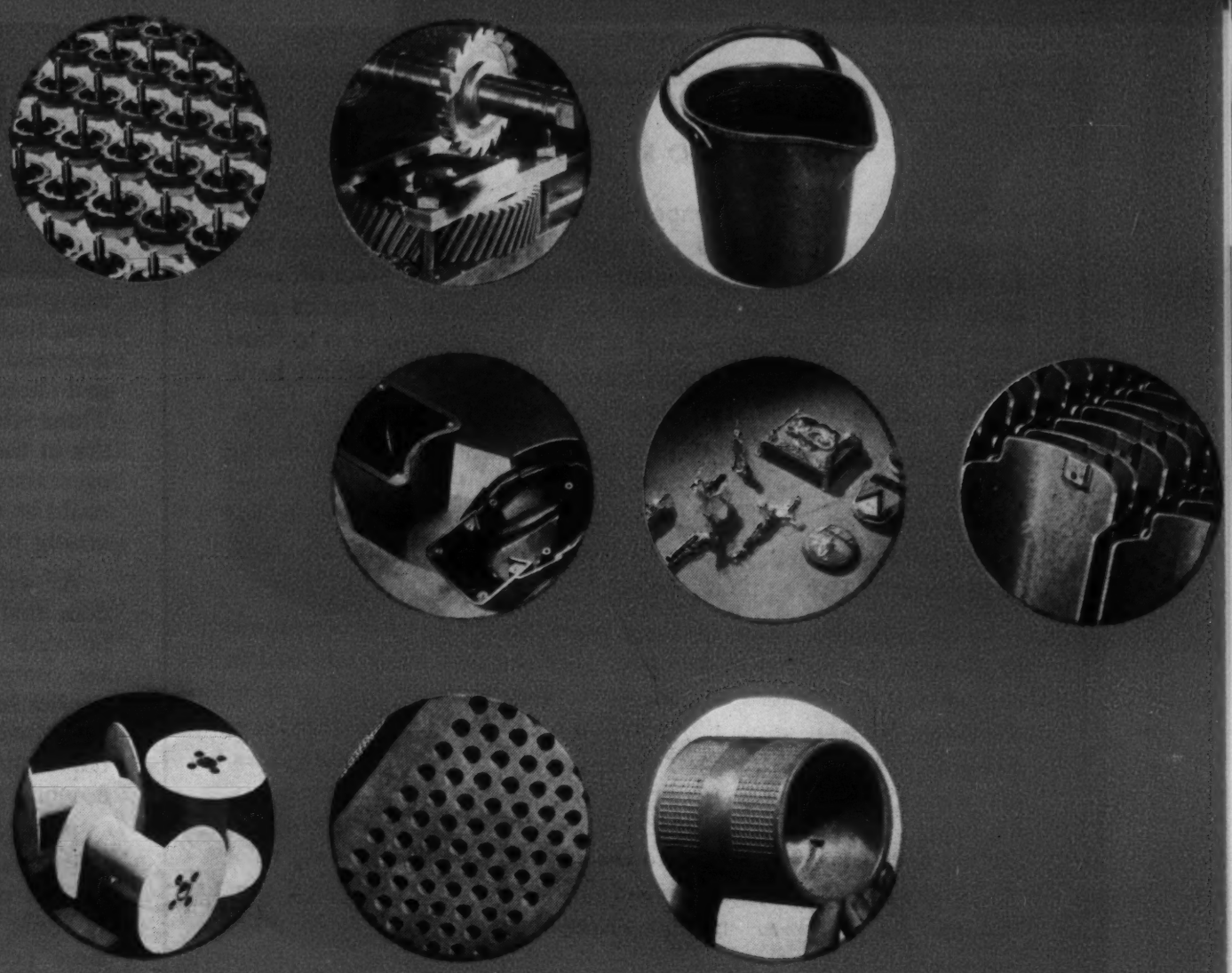
The results of machining the as-cast surface of a series of ½-in. thick rings of 4.00 to 4.18% carbon equivalent to a depth of 1/16 in. are given in Fig 2. These data are plotted on a linear scale in order to show the numerical difference in the tool life values between materials. The rings had a Brinell hardness range of 207 to 223. Their microstructure consisted of pearlite of varying degrees of fineness and, in some rings, different amounts of fine, primary ferrite associated with types B and D graphite. The primary purpose of inoculation is to eliminate or reduce the amount of the latter which forms in thin section castings. Experience has shown that a uniform pearlite matrix structure with a larger amount of longer, coarser graphite flakes machines better than one with a mixed structure of ferrite plus pearlite and significant amounts of tiny particle graphite instead of flake graphite.

The results obtained on machining the same rings to a depth of 1/8 in. below the original surface are given in Fig 3. The microstructure at this level is somewhat different from the surface structure and this fact, together with the higher machining speeds, accounts for the different slopes of the lines. At high speeds the initial wear on the tool (under 0.005 in.) was usually nonuniform, and it was necessary to go to a wear land beyond 0.005 in. for reproducible results. Irons treated with silicon carbide were machined with less rapid tool wear at both cutting speeds. In the cutting tests at 493 fpm, about 20% more metal could be removed from such rings for equal amounts of tool wear. The rate of tool wear was lower in these tests than in the previous series when the rings still had the as-cast surface, which would be expected.

In an investigation of automotive grade iron, the test was used to rate the machinability of ½-in. thick rings of 4.12 to 4.22% carbon equivalent with the results shown in Fig 4. These rings had a Brinell hardness ranging from 207 to 223. Their cross-sectional microstructure was pearlite of varying fineness and different amounts of small carbides at and below the surface.

The graphs plotted from the data obtained in this investigation show the relationship between the machinability of cast iron and its microstructure, which is determined by its chemistry and cooling rate. The method was sufficiently sensitive to indicate the improvement in surface machinability resulting from inoculating the iron.

The tool life-cutting speed relationship is nearly identical when the cast iron miscrostructures are the same. Hence, these charts can be used to select cutting speeds. However, one must remember that they represent the surface machinability of thin section, small mass castings. To determine the relationship for iron castings of like chemistry and, particularly, section size and mass, one should first examine the microstructure to see if it is essentially pearlitic, then calculate the volume of metal to be removed and select the tool life-machining data combination (from the curve) which affords maximum production at minimum cost. The proper cutting speed can be determined readily from the material requirements of the job. Short run jobs normally should be machined without resharpening the cutting tool life so that cutter changes will be economically minimized with the flow of materials and the regular schedule of operations.



Plastics

as Alternate Materials

by T. C. Du Mond, Editor, Materials & Methods

MATERIALS & METHODS MANUAL No. 79

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and applications.

FEBRUARY 1952

Plastics should not be overlooked in seeking alternate materials needed to keep ahead of scarcities and restrictions. These versatile materials have ideal combinations of properties for many applications in which metals have long been considered essential. Engineers investigating their use should consider the plastics as alternate materials, for if the use is as a substitute, then it is probably not satisfactory.

This 24-page Manual describes the types of plastics to be considered as alternate materials and explains their properties and uses in practical terms. Topics covered include:

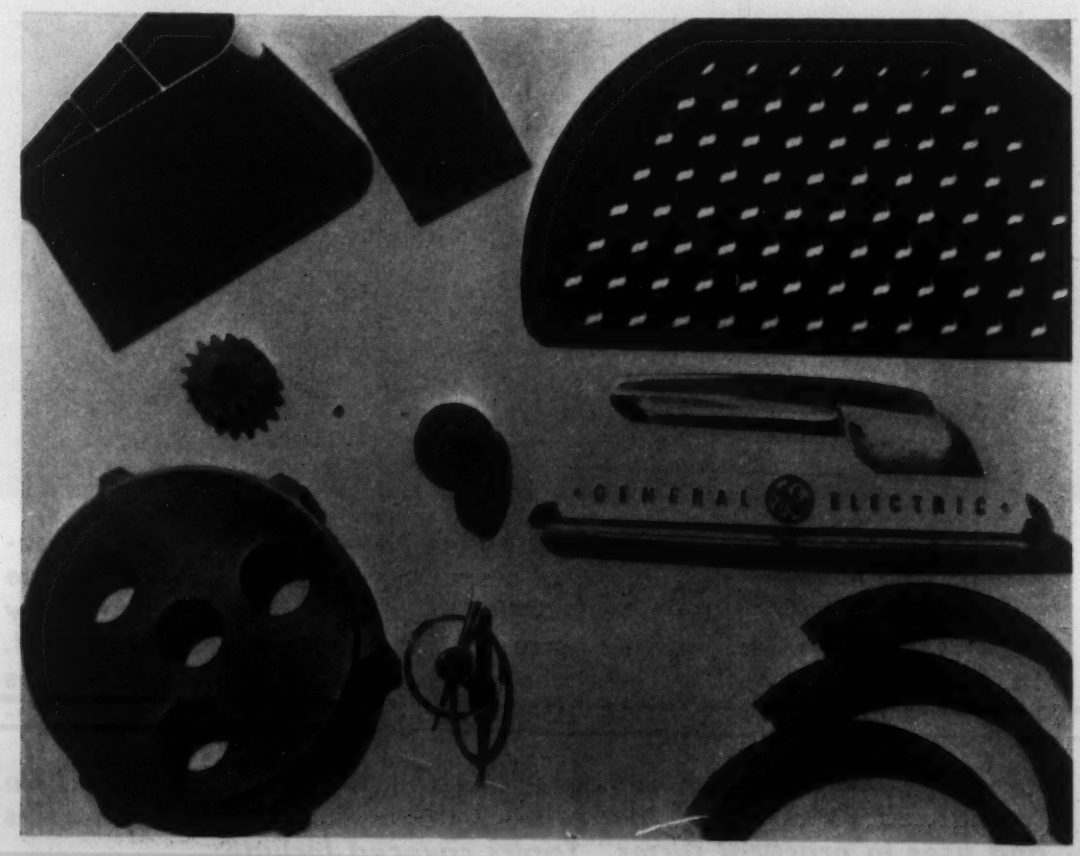
- ***Types and Classes of Plastics***
- ***Properties of Plastics***
- ***Where Plastics Are Being Used***

EDITOR'S NOTE

There are many highly important uses of plastics which are not touched upon in this manual, so a word of explanation might be due. In many uses plastics compete with, or have taken the place of, some other nonmetallic material. Therefore, those uses of plastics have been passed over, since the object of this particular report is to show how and where plastics are being used in applications which have, in the past, been filled with metals.

Our purpose is two-fold. First, plastics are worthwhile engineering materials, and can serve well when chosen and applied with good judgment. Second, with some metals scarce, it is important for materials engineers to be shown how nonmetallic materials—such as plastics—can serve their needs.

In the examples shown on these pages, an attempt has been made to illustrate the uses of most major types of plastics that are used in engineering applications. At the same time, we have tried to show the major fields of application of plastics. In certain instances, one, and only one, plastics material could handle the job. In other cases, any one of two, three or more plastics could meet the requirements. Therefore, in using the information presented here, it is hoped that the reader will consider it primarily as a guide. Before any final choice is made, the materials manufacturer should be consulted. For, although he is anxious for his materials to be used, he is more anxious to have them used correctly.



Today plastics have taken over many applications that once were the exclusive province of metals. Here we see some representative samples which illustrate a few of the fields in which plastics are serving. Shown are aircraft parts, a machine gear, heat exchanger baffle plate, refrigerator door handle and name plate, food machinery part, gas engine piston rings and metallized television dial. All were made by Taylor Fibre Co. from laminated phenolic plastics.

Introduction

That plastics have long since left the field of substitute materials is well recognized by many engineers. However, there are still too many users of materials who do not know where and how plastics can be applied. Those who have not investigated plastics in this period of materials shortages are probably overlooking what could be relatively simple solutions to vexing problems.

As with other materials, it is seldom that a simple replacement can be made so that plastics and metals are completely interchangeable. The application must be studied from many viewpoints, including service requirements, design changes and economics.

Probably the most reluctant potential users of plastics are holding out because of their feeling that plastics are only usable in novelties. These same people overlook the fact that they encounter plastics repeatedly in their everyday lives without realizing how greatly they depend upon these versatile materials.

Plastics and stainless steels share a common disadvantage in that in minds of the uninitiated plastics are plastics and stainless steels are stainless steels. In both instances there are several classes of materials with a variety of grades within the classes. The important point is that there are extensive ranges of properties available to the engineer charged with finding a suitable material for his product.

Plastics cannot and should not be looked upon as panaceas for all materials problems. They are not. Neither could even the most optimistic proponent of plastics claim that they can do everything that metals do. They cannot. The fact remains, though, that where their own characteristics can be used to advantage, plastics are often better than metals. Many will remember that during World War II steel was actually used as a replacement—or substitute, if you will—for reinforced plastics.

Earlier, reference was made to the fact that most of us encounter plastics throughout our existence without ever being aware that they are plastics.

In and about our homes or offices and on our persons we all handle these products nearly every day: telephones, business machine keys, small

radio cabinets, tooth brushes, spectacle frames, fountain pens and pencils, electrical plugs and switches.

Most of these products are made entirely or largely of plastics. Likewise, plastics have become the accepted material for these products.

Also, in our homes are many plastics applications where the use of plastics is becoming the rule and not the exception. These include: refrigerator door liners and compartment doors, food containers and canister sets, kitchen utensil handles and dishes and tumblers.

In automobiles most steering wheels are made of plastics and, in many cases, automotive timing gears and distributor rotors are also made of plastics materials.

Bearings of many kinds are now made of plastics, ranging from small nylon bearings in baby carriages to huge pintle bearings for ships and roll-neck bearings for steel mills.

A roll call of successful applications of plastics could be continued for several pages, but those cited should be convincing proof that plastics can and do meet a widely varied list of requirements.

Today, plastics are being used with success as washing machine tubs and agitators, heat exchanger baffles, aircraft trim tabs, piston rings in gas engines, and in other applications which would seemingly demand metals. The applications listed give some indication of the wide range of potential uses. Most applications now being converted to plastics appear to have a reasonable chance of staying with plastics when a free choice of materials can again be made.

The reason is, as one plastics materials manufacturer sees it:

"There is little evidence of any helter-skelter blind rush into plastics production. Instead, there is a solid engineered swing toward the use of plastics based on sound investigation and planning."

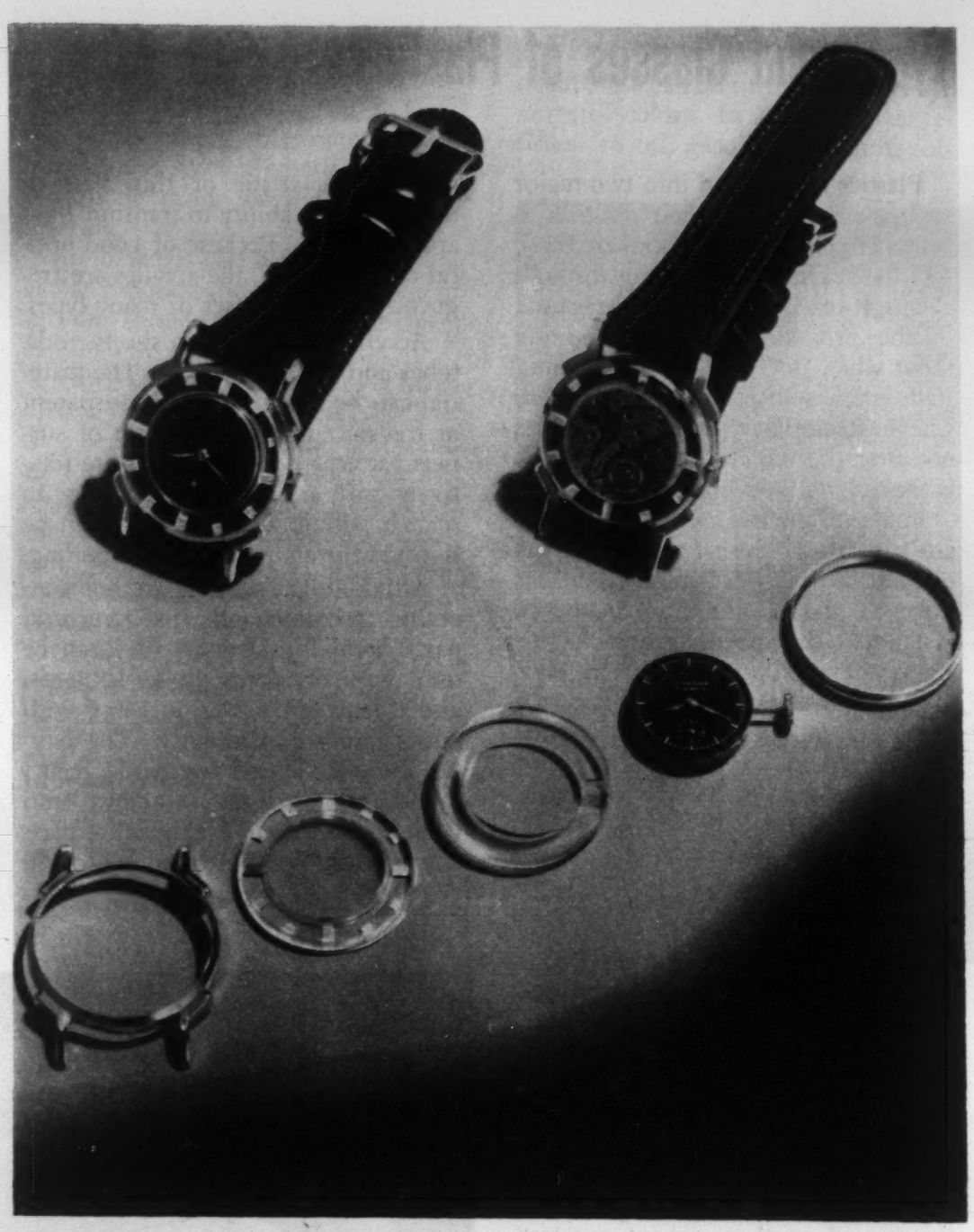
Speaking generally, plastics offer the following properties: light weight, resistance to corrosive chemicals, good impact properties, wear resistance, abrasion resistance, resistance to cold, high dielectric strength, resistance to weathering, wide color range and pleasant feel. To be sure, not all of these properties are found to the fullest extent in any one plastics material, but suitable combinations can be found for most applications.

Many plastics are more expensive, on a per-pound basis, than the metals they seek to replace. Often this disadvantage disappears on a volume-to-volume comparison. Even when materials costs are higher by any standard of measurements, plastics products are frequently less expensive. The latter fact becomes true in many instances because of better finishes attainable on plastics, eliminating the need for any after treatments; also, because it is often possible to combine several sub-assemblies into one molded part.

When considering plastics, it is necessary to realize the many ways in which they can be used. Plain molded parts or laminated sheets are known to all as forms in which plastics are used. In addition, these materials are used as rod and tubing or extrusions by themselves. Some tubing is used over metal; certain plastics can be electroplated or metallized. In other instances metallic inserts are molded into the plastics to provide special properties not attainable in the plastics alone, or the plastics are molded over metal parts.

As indicated, some plastics can be plated or otherwise given metallic coatings. Most of them can be machined and many of them can be joined by welding. Thus, unusual shapes and effects can be attained where necessary, and the usefulness of plastics is extended further.

Before an intelligent choice of plastics can be made, it is necessary to know something about the various plastics and what they have to offer. A final choice should be deferred until the proposed application is approved by the material suppliers. Most of the plastics industry is vitally interested in seeing that plastics are employed only where they can be used satisfactorily. Therefore, the judgments of these specialists should be sought and relied upon.



An unusual application of plastics is in the making of a novelty watch case molded of acrylic plastics by American Plasticraft Co. Molded in two sections, with gold-plated numerals embedded in one half, the two crystals are joined by a pair of gold plated bezels.

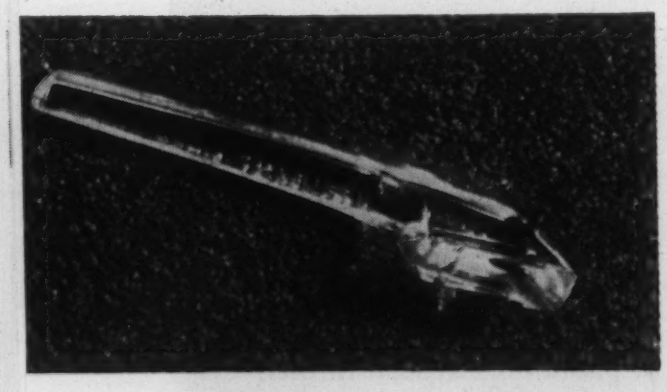
Types and Classes of Plastics

Plastics are divided into two major groups according to their reaction to heat. *Thermosetting* plastics are those which set after the molding through chemical reactions set up by heat used in the process. *Thermoplastics* are those which revert to the semi-liquid state when sufficient heat is applied. The heat employed in molding does not alter the material appreciably, as is the case with thermosetting plastics.

Materials in the two basic groups are used to produce two other types of plastics—plastics laminates and reinforced plastics. In the majority of instances either phenolic or polyester resins are used in conjunction with glass-fibers, mica, paper, or any one of several other materials. In both types, the combination of resin and base material produces an exceedingly strong, stable and useful material.

Thermoplastics

Thermoplastics are plastics which undergo no great chemical change when subjected to heat. They solidify with heat and can be remelted. There are a greater variety of plastics in this group than in the thermosetting type, and properties cover an extremely wide range. The types described here are those most used for rigid products, as opposed to those whose greatest use is in sheeting, film and coating materials.



Acrylic plastics find many applications because of their clarity and transparency. This acrylic door handle molded by Erie Resistor Corp. replaces metal on a popular make of refrigerator.

Acrylics

The plastics commonly known as acrylics are outstanding for their resistance to weathering. In addition, they are light in weight and resist shattering from heavy blows. An unusual characteristic of this class of material is its ability to transmit light around bends. Because of good optical characteristics, the acrylics are frequently used as lenses of many types.

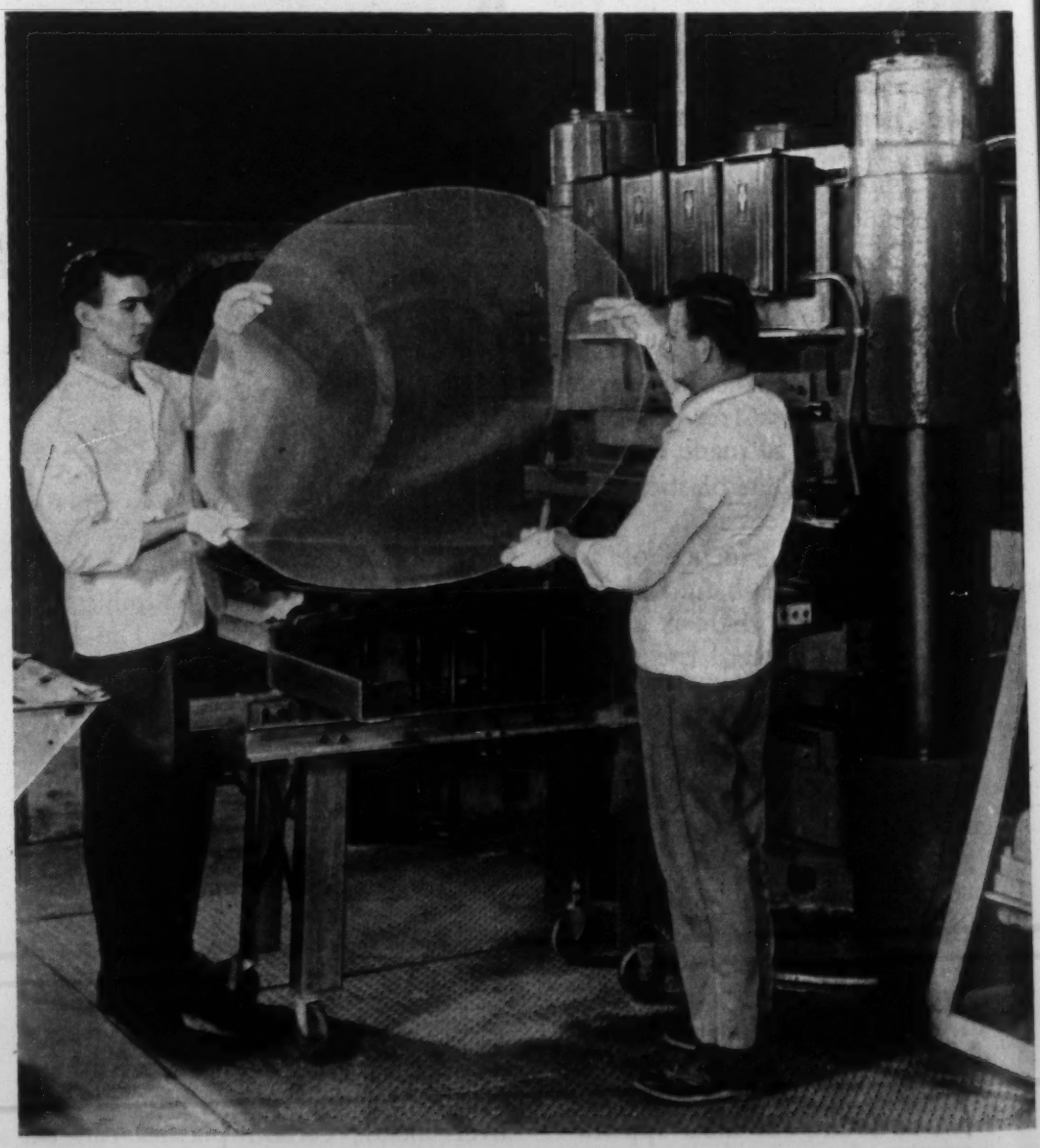
Acrylics can be had in sheets, rods, tubes and molded objects. The material can be made opaque, transparent or translucent, with a variety of surface patterns. These plastics are relatively soft and have a tendency to scratch, although the surfaces can be restored through sanding and buffing.

Although the acrylics are not generally recommended for structural parts involving stresses, they can be used with pressures up to 1000 psi and at temperatures up to 140 F with reasonable life expectancy. The acrylics are widely used for lenses, reflectors, and airplane windows and frames. Lucite and Plexiglas are plastics of this type. Heat of a lighted cigarette is sufficient to soften the acrylic plastics.

Fluorocarbons

Within the last few years, there has been developed a family of plastics which are outstanding in their resistance to corrosive materials and in their retention of properties over a wide range of temperatures. Kel-F, Teflon, Fluoroflex and Fluorothene are the trade names of these materials.

The fluorocarbon plastics have outstanding dielectric properties and high impact strength. There is no known solvent for these materials. They will suffer some attack from molten alkalies and under some conditions fluorine will attack them. The plastics can be used at temperatures up to 500 F and as low as –100 F. Materials of this type can be given added strength by orienting through



Kel-F, an extremely inert plastics, is widely used in chemical processing. Shown here is a solid 45-in. disk of the material which weighs 16 lb. The part, fabricated by U. S. Gasket Co., is to be used as a gasket in a chemical plant.

cold drawing or rolling. When thus treated, the plastics have elastic memory and will revert to original shape when loads are released.

The plastics are not hard and can, therefore, be scratched. Because there are no solvents which can dissolve the materials, there are no readily employed bonding methods to use in fabricating this type of plastics. Fluorocarbon plastics are extremely high in cost.

Properties of these plastics make them highly useful for handling hot and corrosive liquids and as insulation in high frequency and high voltage electrical equipment.

Rigid Vinyl Chloride

Recently there has been developed a rigid type of vinyl plastic which offers high strength, light weight and good resistance to breakage. The plastics material is resistant to most inorganic chemicals and organic materials. At ordinary temperatures, the vinyl is unaffected by alkalies, acids, salts, oxidizing agents, oils, greases, alcohols, gasoline and carbon tetrachloride. There is no change in stiffness at temperatures from −70 to +70 F.

Ketones, ethers, chlorinated hydrocarbons and some aromatic hydrocarbons will cause swelling in vinyl chloride.

Rigid vinyls can be welded by hot gas techniques and can be drawn or vacuum formed by heating the sheet to 300 F.

Vinyl chloride is offered in many places where stainless steel or lead is generally used because of chemical resistivity of the plastics. The material is used in making fume ducts for corrosive chemical vapors, tanks, tank linings, extruded pipe, instrument cases, tote boxes and many similar products.

Geon 404 is a resin of this type which is sold in various forms under trade names of fabricators.

The Cellulosics

Cellulose acetate is a widely used thermoplastic molding compound. It is tough, has good impact strength and dimensional stability, is water resistant, and can be furnished in a wide range of colors. In addition, it is resistant to oil, gasoline and mild solvents. These plastics can be machined after molding and can be bonded by adhesives. They are used in applications where relatively low loads are involved, such as in toys, automobile hardware, small motored appliances and business machine keys.

The electrical properties of plastics are well known. Here is an example of one use of these characteristics. Tenite cellulose acetate butyrate is used for the housing of this combination fuse puller and fuse tester. In this application, dielectric strength, impact resistance, transparency and low heat conductivity are all used to advantage.

The usefulness of many plastics is extended by their weldability. Here a rigid vinyl pipe and flange are being joined by a gas welding process. The material, known as Boltaron 6200, is light in weight, has high tensile strength and good impact properties.

Cellulose nitrate is the toughest of all thermoplastics and was the first important thermoplastic to be developed. It cannot be molded, therefore it must be fabricated from sheet, rod and tube. Cellulose nitrate is water resistant and flexible. These plastics are flammable, thus cannot be used near open flame or at high temperatures, and are not recommended where severe weathering will be encountered.

Cellulose acetate butyrate is a member of the cellulosics family also good in impact resistance. It is useful over a fairly wide temperature range. With an ultraviolet inhibitor in the plastic, it also has good resistance to outdoor weathering. It is not affected by gasoline or many cleaning fluids except

those of the carbon tetrachloride family. This plastic is used frequently in automotive steering wheels, fruit juicers and many other types of handles.

Ethyl cellulose retains its toughness and flexibility even at low temperatures. It also provides good electrical properties and is resistant to alkalies, weak acids and moisture. Ethyl cellulose is used extensively for making mechanic's tool handles, steering wheels and vacuum cleaner parts, communication equipment and many military parts involving severe exposures.

Plastics in the cellulosics group include those under the following trade names: Ethocel, Hercocel, Nixon, Lumarith, Plastacele, Tenite, Nitron and Pyralin.

Vinylidine Chlorides

Physical and chemical properties of this class of plastics are comparable to those of vinyl chloride but have lower processing temperatures. The vinylidine chloride resins are soluble in the better solvents. Plastics of this type are extruded and injection molded. They have good welding characteristics and can be given increased strength by orientation.

Vinylidine chlorides are not recommended for use where high impact or shock resistance is necessary nor where flexibility is required at subfreezing temperatures. Injection molded plastics of this group are extensively used for valve seats, nozzle tips and similar small parts. Geon and Saran are plastics of this type.

Polystyrenes

Plastics in the polystyrene group have exceptionally good electrical properties. In addition, they are resistant to acids, alkalies, salts, the lower alcohols and aliphatic hydrocarbons. Polystyrenes have excellent dimensional stability, even at low temperatures. Except in the high impact types, polystyrenes are relatively brittle. However, more severe applications can be handled through proper design.

Polystyrenes can be machined and bonded for assembly after molding. Parts made of these plastics have brilliant clarity and include such products as radio cabinets, clock and camera cases, refrigerator parts, knobs, pulleys and shaver housings. Trade names of polystyrenes include Ampacet, Bakelite, Catalin, Koppers, Lustrex, Styron and Textolite.

Polyethelyenes

Plastics in this group are remarkably inert to solvents and corrosive chemicals and have a low water absorption rate. Polyethelyenes are flexible and tough over a wide temperature range and have good electrical properties. Tensile strength can be increased by orientation through cold drawing. Lightness of the material is such that products made of it will float.

Polyethelyenes are most widely known through their use in the so-called squeezable bottles, but are also widely used, instead of lead, for cable jackets and to make refrigerator trays, mixing bowls and waste baskets. These plastics are available under the Alathon, Bakelite and Polythene trade names.

Nylon

One of the most widely applied thermoplastics for mechanical parts is nylon, which is extensively used for bushings, bearings, cams and gears. Nylon is light, tough, flexible, resistant to chemicals, and will withstand distortion at temperatures up to 380 F.

Nylon is available in various forms, including rod, tubing and molded parts. Rod and tubing can be machined, and many small parts are made on automatic screw machines. Molded gears can be made to extremely close tolerances, thereby eliminating any subsequent machining.

Thermosetting Plastics

Thermosetting plastics undergo a chemical change when heat is applied during forming a material which is substantially infusible or insoluble. There are fewer thermosetting plastics that can be considered as alternate materials for metals, although those that are useful find extremely wide application both in molded products and in laminated and reinforced materials.

Phenolics

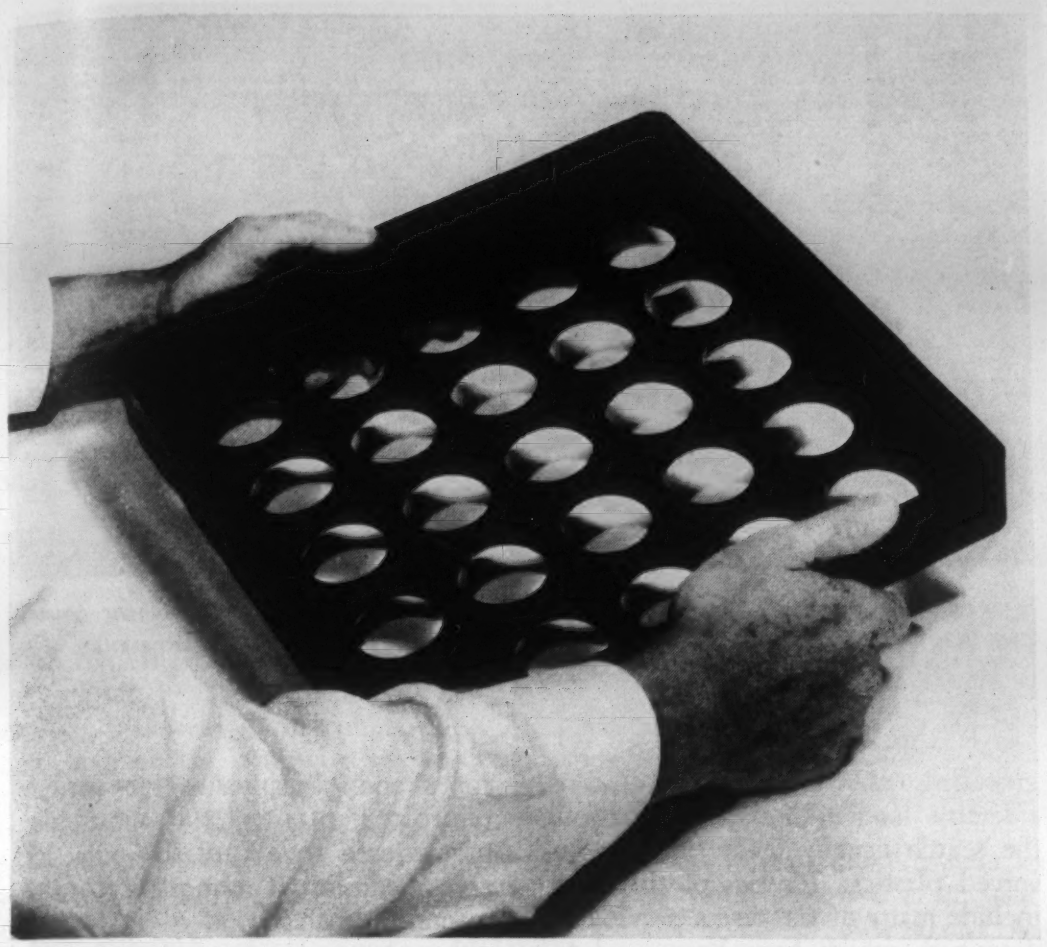
The phenolics are rated as among the hardest of the organic plastics and are capable of giving good service

PLASTICS USED FOR PRINTING PLATES—FEATURED IN THIS ISSUE

One of the most revolutionary applications of plastics has been in the Graphic Arts, an industry bending to an economic back-breaking under the weight of metals in archaic printing methods. Plastic printing plates are now replacing copper and zinc. All of the illustrations in this section were printed from plastic halftone plates made mechanically on a machine called the Fairchild Scan-a-graver.

An estimated 1500 daily and weekly newspapers are using the process, which was introduced in February 1949. Within the last year the Fairchild Camera and Instrument Corp. of Jamaica, N. Y., manufacturers of the machine, have marketed a new model adaptable to magazine and commercial usage. The pictures you see here can be identified as printed from plastic plates only by an expert, and this issue is an example of what is to come.

The material used by the Scan-a-graver is a thermoplastic fabricated by the Fairchild Corp. The "etching" principle of the machine is a burning process using a heated stylus tool. Because the plastic is much more economical than copper or zinc, and because the operation of the machine is a nonskilled part-time job, the economic advantage is obvious. Also, since both copper and zinc are critical materials, users of halftone plates are turning to plastic "cuts", which are exempt of restrictions.



Precision artillery parts are carried throughout their entire production cycle in tote trays of Rogers phenolic resins. The trays must stand immersion in hot water, steam blasts and rough usage without breakage, distortion or warpage.

under difficult conditions. Phenolics are resistant to heat, water, mild acids, alcohol and all common solvents, oils, greases, soaps and detergents. Special formulations can be provided to resist severe chemical action.

The phenolics are strong and light in weight. Special strength, electrical and impact properties are provided through the use of filler materials, which include: wood flour, chopped fabric, mica, asbestos, cotton flock, chopped paper and silica. These compositions lend themselves to molding around inserts for special properties.

One of the characteristics of phenolics which has led to their extensive use is their electrical resistivity. In addition, these plastics have good surface appearance, low thermal conductivity and low water absorption. Phenolics do not support combustion and can be used at temperatures ranging from 250 to 475 F, depending upon the composition and filler material used.

Among the many uses for phenolic plastics are telephone hand sets, electrical switch parts, utensil handles, business machine cases and housings, camera cases, washing machine agitators, radio cabinets, pulley wheels, gears, bearings, tooling and dies. Phenolics are available under the following trade names: Bakelite, Durez, Durite, General Electric, Insurok, Nobellite, Resinox and Rogers.

Ureas

The urea family of thermosetting plastics offers an unlimited range of color possibilities, with good mechanical and electrical properties, and are completely resistant to organic solvents. These materials have high surface hardness, high strength and excellent dimensional stability. With the exception of a relatively high water absorption rate, the ureas are comparable to some phenolic resins. Filler materials are not used.

Ureas are not recommended for continuous use at temperatures above 170 F, although short-time exposure to 250 F is possible. Mechanical properties vary little between —70 and +170 F.

In laboratory fume hoods, ureas last longer than wood or metal. Other uses include: housings of various types, boxes, electrical parts and novelties. Beetle, Plaskon and Sylplast are the names under which ureas are sold.

Melamines

The melamine plastics are of the same general family as the ureas and offer good surface hardness, excellent electrical properties and excellent resistance to moisture. They are used with various filler materials to provide improved properties. For example, chopped fabric filler increases shock resistance. Melamines are unaffected by common organic solvents, greases, oils, weak acids and alkalies. In addition, they are insensitive to heat and are flame resistant. They can be used from low temperatures up to 210 to 250 F, max, depending upon the filler materials. Metal inserts can be molded into melamine parts for fastening and special properties. Most common current uses of melamines include tableware and automotive ignition parts.

Common trade-names of melamines are Melmac, Melantine, Plaskon and Resimene.

Alkyds

Alkyd plastics are most widely used in electrical and mechanical parts. They are rated as excellent in dimensional stability, heat resistance and resistance to moisture and, in addition, have good electrical properties. They are used chiefly in mechanical and electrical parts.

Among the recent uses of alkyds are in motor starters, capacitors, connectors, fuses, starter coils, television tube supports, and tuning devices.

A recent development in the alkyd plastics is a chopped glass fiber reinforced material which has exceptionally high impact strength. Material of this kind can be molded into a variety of shapes at comparatively low pressures and temperatures.

Most alkyd plastics are supplied under the Plaskon trade name.

Polyester Resins

Polyester resins are used primarily in conjunction with reinforcing materials to provide exceptionally strong and tough materials. Glass fibers in various forms are currently the most generally used reinforcing materials. Reinforced materials so produced can be made in various formulations which provide finished materials that range from hard and rigid, to semi-rigid and tough, on through to being almost rubber-like.

Resins of this family are used to make products ranging from fishing rods to boats and including chemical tanks, structural parts for transportation equipment as well as housings of various kinds.

Polyester resins are known by a

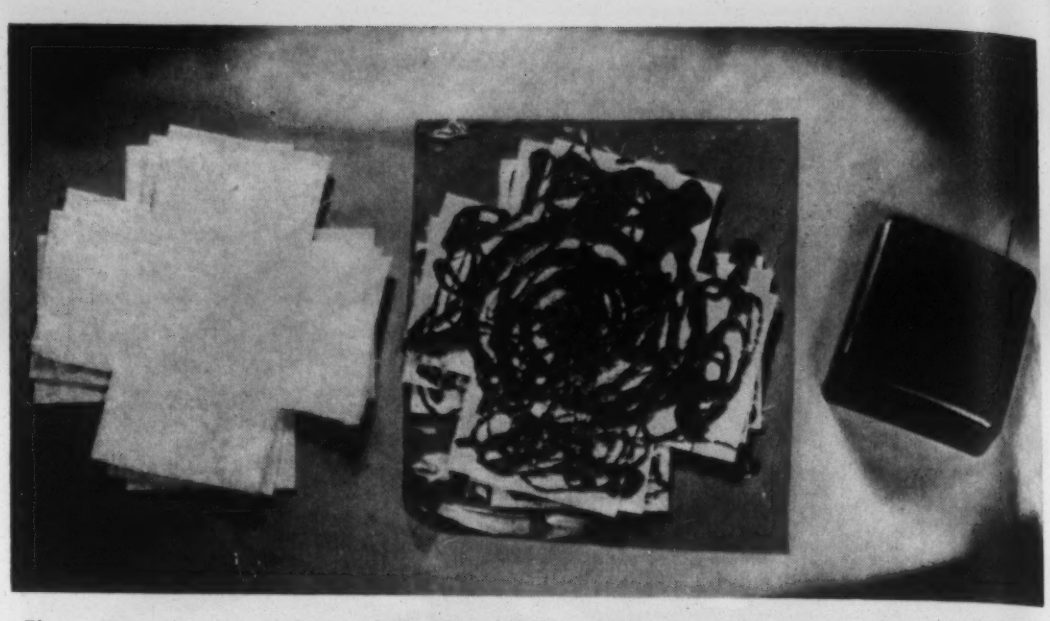
number of trade names, including: GE, Laminac, MR, Paraplex, Plaskon, Selectron, Synvar and Vibrin.

Rubber Plastic Blends

A new type of thermosetting material, a plastic-rubber blend which can provide a range of properties, is now coming into more general use. Originally, the material was expected to compete with hard rubber, but it now is considered for certain applications which have formerly been filled by nylon and the phenolics.

Enrup, an important material of this type, can be made to vary from an elastic material to one that is hard and brittle. Among its characteristics are good resistance to oils, solvents, acids and mild alkalies; good electrical properties and good dimensional stability up to 250 F and higher.

Uses for rubber plastic blends include heavy-duty gears, washing machine parts, valve seats, water pump impellers, and many parts where chemical resistance is the chief requirement.



These are steps in making glass fiber reinforced plastics parts by the plunger process. First (left) is the pre-cut glass fiber mat; next, the laid up mat with thermosetting resin poured on; and finally, the finished shape.

Reinforced Plastics

When plastics are sought for engineering applications where considerable load or impact is required, the search usually leads to the reinforced plastics. Plastics of this type include many of the resins previously described, which have been used to impregnate any *filler*, and reinforcing materials such as paper, cotton, linen, glass cloths and chopped fibers of these and other materials.

Although melamines, Epoxys, silicones and other resins are used in reinforced plastics, the most commonly used today are the polyesters and phenolics. The most favored reinforcing material is glass fiber in either chopped, mat or cloth form.

Plastics gears are now being made in extremely large size. This Enrup gear blank produced by U. S. Rubber Co. has an outside diameter of 30 in., is 4 in. thick and weighs 120 lb. Machined gears are generated on standard metal working equipment.

High Pressure Laminates

One form of reinforced plastics is the result of high pressure molding methods which produce an extremely dense material. Laminates, as these are known, are usually available only in simple shapes such as sheet and tubing. However, parts of other shapes can be produced from these basic forms by machining. Materials in this group are familiar to most people through their use in table and counter tops. However, they are used extensively for many industrial applications as, for example, steel mill roll neck bearings and other heavy duty bearings, machine tool ways and other parts subjected to heavy wear, abrasion and heat. Of course, these materials have long been used extensively in the electrical industry.

Low Pressure Laminates

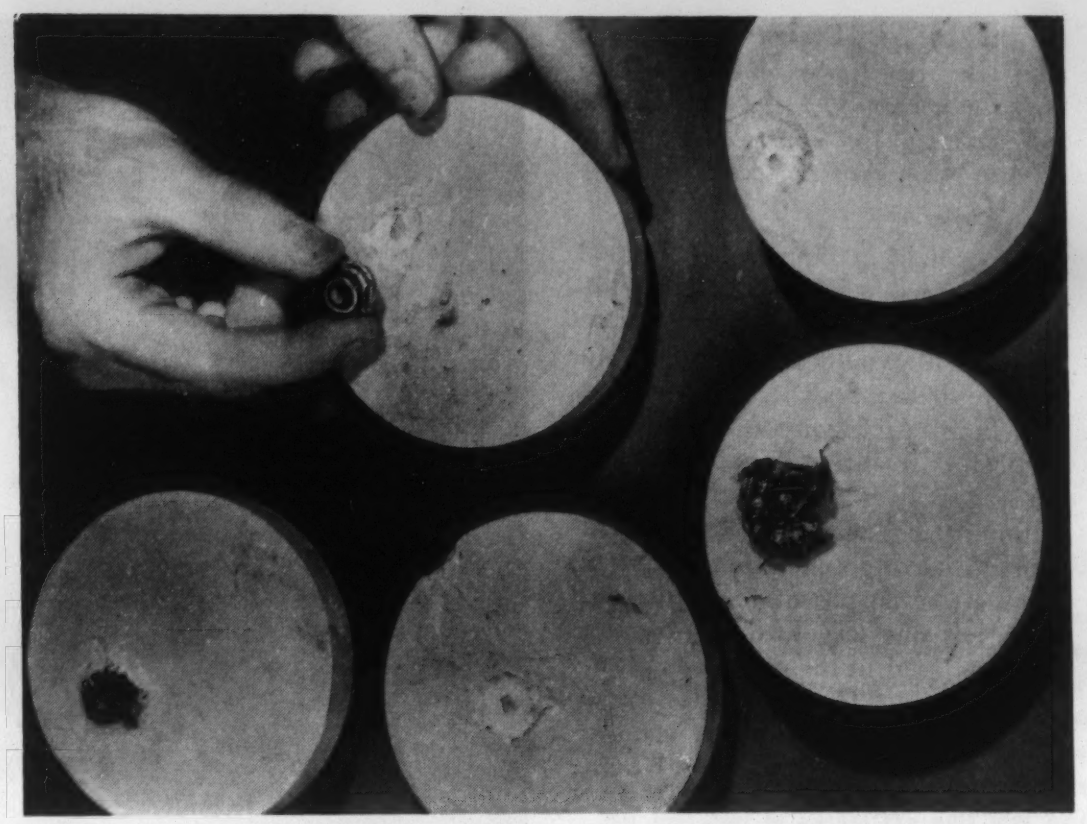
Basically, the same materials combinations as are used in high pressure laminates are available in low pressure laminated form. Complex shapes can be provided in low pressure laminated parts by any of several molding techniques. The method is employed to make such parts as airplane doors, aircraft vent ducts, boats, auxiliary fuel tanks for military aircraft, washing machine parts, and many more. Many shapes readily made in low pressure laminates are too complicated to be made of metals

without extensive secondary and assembly operations.

Laminated plastics of both high and low pressure types are lighter than aluminum and weight-for-weight are stronger than steel. Most combinations are extremely resistant to chemical attack, have good electrical properties, and will not rust or rot.

Compression Molded Reinforced Plastics

One of the recent developments in plastics is the perfection of molding materials and methods to permit glass fibers to be used as reinforcements in resins formed by compression molding. The advantage of such reinforcement is, of course, the great increase in strength of the molded products. Polyesters and alkyds are already being used in compression molded parts, and the practice is soon expected to spread to other resin groups.



Impact resistance of glass fiber reinforced alkyd plastics is dramatically illustrated through being hit by 45-cal slugs fired at 30- and 50-ft distances. Although the Plaskon disks were chipped, they remained intact.

Properties of Plastics

Because most plastics were developed for specific applications, or to provide certain characteristics, there is a wide range of properties in plastics. Therefore, in considering plastics for a proposed application, the engineer will be wise to look for those which seem to meet his major requirements and from them pick the one which will do the job best.

Properties of plastics, both physical and mechanical, are listed in much the same fashion as comparable properties of metals are listed. However, most mechanical properties of plastics are measured by methods that are similar to, but still different than, those employed in rating metals. Therefore, there is no direct comparison between the two groups of materials other than actually testing them under identical conditions.

As with metals, properties charts should only be used as a basis of comparison between plastics materials. Final testing should be done on a finished product because variables in fabricating methods and testing conditions could result in misleading conclusions.

In considering the properties of plastics, engineers should think of them as combinations of properties rather than as individual properties. For example, the reasons for using a plastics material might include light-weight, impact resistance and wear resistance. Those would be the reasons for choosing phenolic laminated gears, an application where the low modulus of elasticity and low mass keep impact and acceleration loads to a minimum.

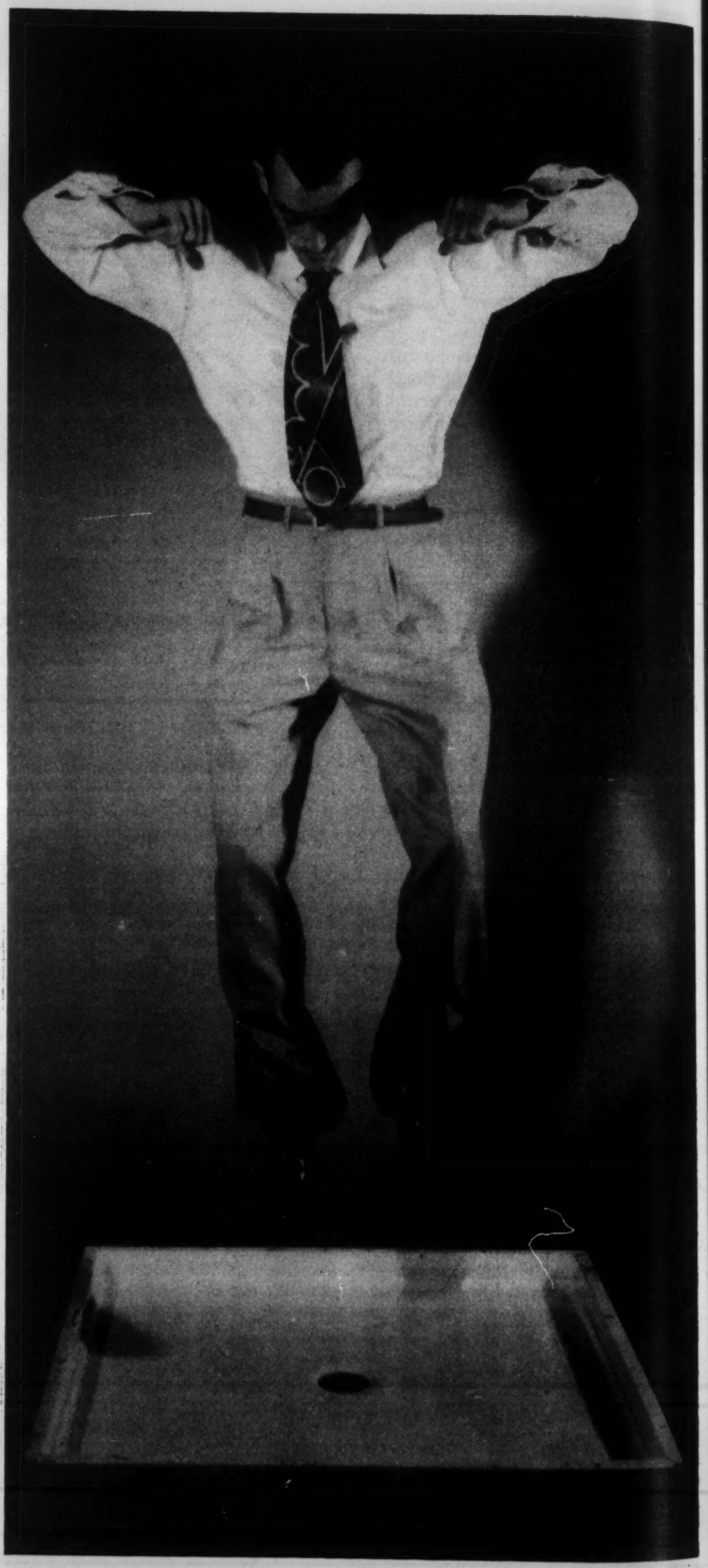
In the cases of a door knob or business machine housings, the inherent color and gloss of plastics materials provide a permanent, long wearing finish. At the same time, low heat conductivity of plastics make articles made from them comfortable to the touch. The same feel can be given to machine control knobs and hand wheels because of the identical characteristics of plastics materials.

Historically, the outstanding property of plastics has been impact strength. That was a property sought when Hyatt in 1870 developed a material from which to make billiard balls by plasticizing cellulose acetate with camphor This was the first successful plastic material. The same impact strength has been responsible for many plastics applications ever since.

Impact Resistance

Impact resistance in plastics is different than that same property in metals. In metals, impact strength, or toughness, usually results from ductility. In plastics, impact strength is a combination of low modulus of elasticity and inherent toughness. Plastics are somewhat rubbery in nature; in fact, synthetic rubber could be considered as a type of plastics material. The more rigid plastics receive their impact resistance from a moderately low modulus of elasticity or from fibrous materials, such as cotton, glass or wood fibers used as reinforcement.

Impact resistance for any plastics can be expressed in foot-pounds, but potential users should be more interested in the effect of impact upon the finished article itself. More and more users of plastics materials use a drop test or some similar test to determine impact resistance.



The strength of a Laminac impregnated glass fiber stall shower base is tested by a man jumping on it as hard as possible. This 20-lb base compares with 80 lb for one made of steel.

To explain, a housing of molded cellulose acetate butyrate would only be fractured by a much more severe blow than would be required to severely dent a drawn steel or aluminum housing. Hammer faces of nylon, cellulose nitrate, or ethyl cellulose can deliver a high impact blow without being dented themselves and without marring a metal surface.

Impact resistance of thermosetting plastics is due largely to reinforcing materials used in them, such as glass, cotton or wood fibers with polyesters and alkyds. Thermoplastics achieve their toughness from their high molecular weight and their chemical make-up. For example, polystyrene is rigid and relatively low in impact strength, while polyethylene is flexible and quite tough.

Abrasion and Wear Resistance

Although some plastics materials have relatively soft surfaces, many of them offer good wear and abrasion resistance. In some plastics, these properties often stem from softness and rubberiness rather than from hardness. For example, plasticized polyvinyl chloride is abrasion resistant and scratch and mar resistant in much the same way as is rubber. At the other end of the scale, one of the hardest of the common plastics is melamine formaldehyde of the type used in table and counter tops. This resin is extremely hard as compared to other plastics but relatively soft when compared to glass and ceramics. The other plastics lie between these two groups in wear resistance.

Wear resistance, as in the moving parts of mechanisms, is a direct result of relatively high compressive fatigue strength coupled with a low modulus of elasticity.

Bearing Qualities

The combination of impact strength, and wear and abrasion resistance explains why plastics have been highly successful in gears, bearings and various types of wearing blocks, cams, and sliding machine tool ways and elevator gibs. In most cases where plastics serve as bearing surfaces, some lubricant is present. The low modulus of elasticity of plas-

tics provides excellent conditions for the establishment and maintenance of a lubricating film—better than that existing in many metals and other more rigid materials.

Because plastics in bearing applications are most generally used in contact with hard, smooth metal surfaces, there is little likelihood of galling from localized pressure and heating.

Plastics are often used, without lubrication, as friction elements in clutches. Molded brake blocks and clutch disks are also made from plastics with special characteristics.

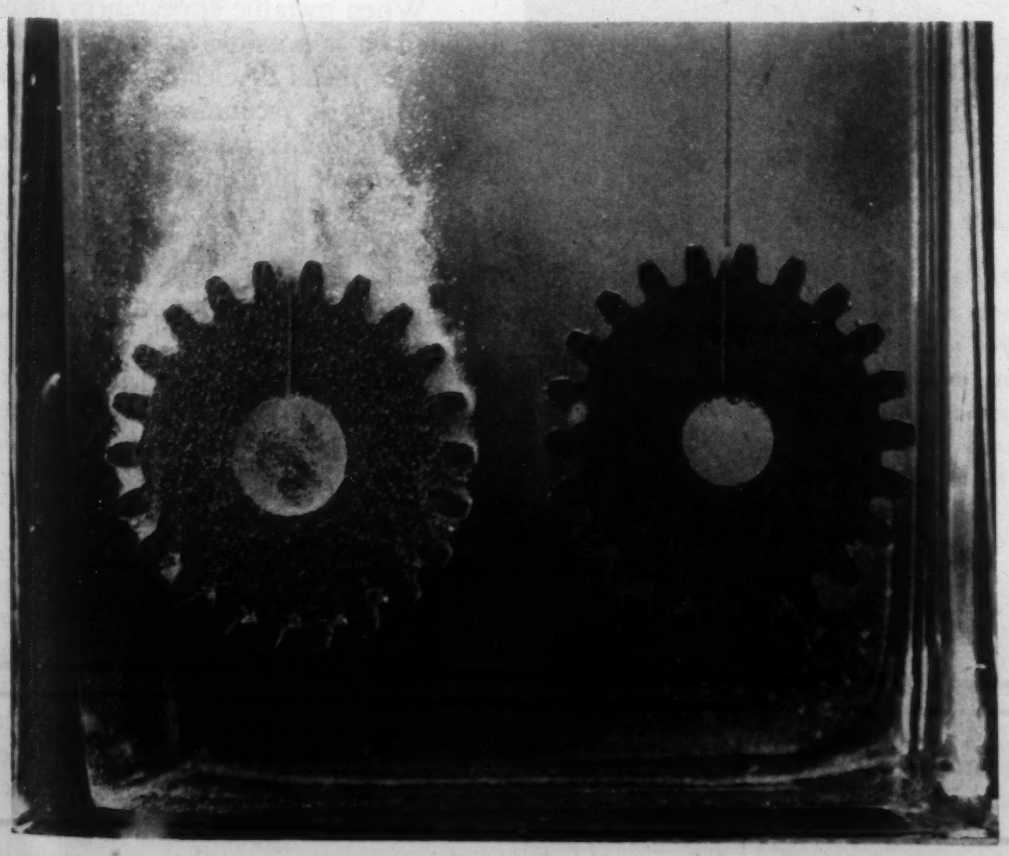
Use of plastics at both ends of the friction scale gives point to an engineering maxim that in many ways, a good bearing material is also a good brake or clutch material. The difference lies in lubrication or the lack of lubrication.

Corrosion Resistance

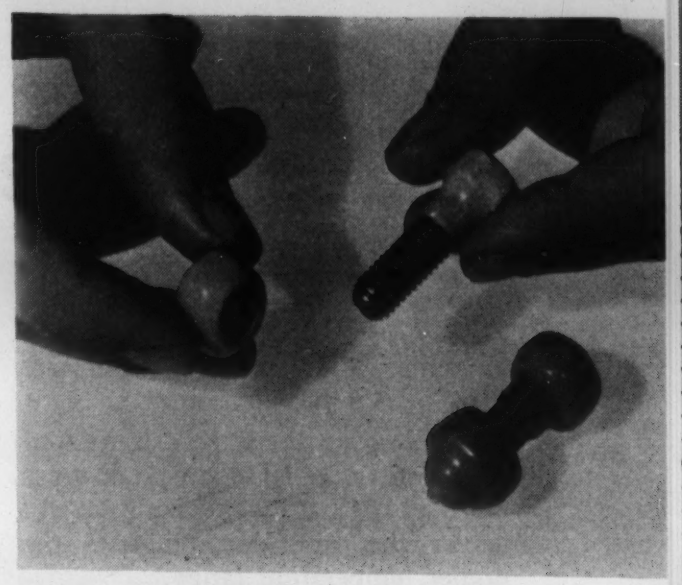
Some of the most widespread plastics applications are due to their ability to withstand the destructive attacks of atmospheres, acids, alkalies and solvents. Not all plastics are resistant to all of these destructive conditions, but most offer resistance to atmospheres and conditions which would be highly corrosive to metals.

Generally speaking, plastics can be used without rapid deterioration in the presence of mild acids and alkalies. Some plastics are extremely resistant to even the most corrosive and reactive chemicals. Materials such as Teflon and Kel-F will resist fuming nitric acid, as well as high concentrations of sulfuric and hydrochloric acids. Phenolics are widely used in the viscous rayon industry to withstand moderate, dilute sulfuric acid solutions. Polystyrenes make good battery cases and retainers for battery separator plates. Polyvinyl chlorides in the form of micro-porous sheet is also good for storage battery separators. Melamines are resistant to alkalies, and polyethylenes and polyvinyl chlorides are both used as corrosion resistant linings or piping for corrosive chemicals. Polyethylene is used to make bottles and carboys for transporting acids.

However, caution must be exercised in the use of plastics in the presence of the things which attack them. Aromatic hydrocarbons will attack polystyrene, which is completely immune to any effect of long-time immersion in water. Polyvinyl alcohol compositions, on the other hand, are completely immune to a wide range of extremely active organic solvents, but are swelled and partially dissolved by water. Many plastics films are somewhat selective as to their penetration by organic vapors, while metal films completely stop all vapors except where mechanical pin holes exist in the thin metal.



Chemical resistance of Enrup, U. S. Rubber's new thermosetting plastics, is demonstrated here. A steel gear (left) and a molded Enrup gear are both immersed in a 20% solution of sulfuric acid. The bubbling effect on the steel gear is caused by corrosive action of the acid on metal.



The chemical resistance of vinyl plastics has earned many unusual applications for the materials. Here vinyl-encased low carbon steel nuts and bolts are used to replace stainless steel fasteners in equipment of Industrial Rayon Corp. The Goodrich plastics are used to encase the nuts and bolts by Steere Enterprises, Akron.

Water Absorption

Water absorption in plastics materials is a function or result of the chemical make-up of the plastics. Hydrocarbon plastics, such as polystyrene, polyethylene, polyisobutylene and some of the styrene copolymers, will absorb practically no water.

Those plastics materials which are derived from cellulose or have cellulose fillers will take up varying amounts of water. Ethyl cellulose, cellulose acetate, acetate butyrate and the cellulose-filled phenolic molded and laminated products absorb moisture into the cellulose filler while the phenolic resins remain substantially unaffected. Considerable control is possible in water absorption of cellulose, the property depending upon the degree to which the cellulose is impregnated by the phenolic resin.

Plastics, such as polyvinyl chloride, the acrylics and most thermosetting plastics, are highly resistant to water and have low absorption rates.

Moisture resistance of plastics must be considered when applying these materials as components of devices in which close tolerances must be maintained. Swelling in plastics, due to moisture, can be gaged rather accurately by the water absorption rates.

Temperature Resistance

Plastics, being organic materials, can be said, generally, to undergo more broad changes in properties at varying temperatures than do metals

in the ordinary temperature ranges.

Most plastics have been assigned their applications because of their nominal properties at approximately room temperature. Therefore, when plastics are to be employed at temperatures below O/F or higher than 120 F, their properties should be checked for suitability. Thermosetting plastics, as a group, are less affected by either high or low temperature than are the thermoplastics.

To illustrate, the impact strength of a phenolic material might go down as much as 15% at low temperature and up by the same percentage in the higher temperature range.

Thermoplastic materials, particularly those which trace their flexibility to the use of added plasticizers, are usually more sensitive to extremes in temperature. They are likely to become brittle at sub-zero temperatures and unduly soft at elevated temperatures.

Within the last few years, the service range of temperatures of plastics has been broadened considerably by the advent of fluorocarbon resins (Teflon and Kel-F) in the thermoplastics field and silicone resins in the thermosetting group. These newer materials have pushed the upper operating temperatures for plastics to 400 F and above, and yet these same materials have good flexibility at extremely low temperatures.

Tensile Strength

The tensile properties of plastics are frequently highly directional in their characteristics. The use of oriented fibrous fillers, such as cotton, nylon, glass or wood, in thermosetting resins can advance the tensile strength of these plastics up to a point where they compare favorably with high grade steels.

Among the thermoplastic materials, orientation effects can be obtained. An example is stretch oriented polystyrene sheet which can be used in applications formerly filled by steel and aluminum. Venetian blind slats are typical of this type of application. Stretch oriented polystyrene can be formed without loss of orientation.

In industrial applications, the user of plastics should look more closely at the rigidity of the material, together with the temperature at which deformation takes place under load. In applications where a dynamic load is put on a plastic, the normal fatigue factors should be applied, that is, a factor of anywhere from 5 to 10.

Light Weight

Low specific gravity of all the plastics is extremely important in applications which require a high ratio of strength to weight or where lightness alone is an advantage. Likewise, the light weight is an advantage in applications involving movement or transportation at high speeds or in mechanical components requiring low inertia. For the sake of comparison, most plastics weigh less than magnesium.

Flammability

Flammability, or lack of it, is important in considering plastics for specific applications. A few plastics will burn readily when in contact with an open flame; others are difficult to ignite, and many of these are self-extinguishing. All plastics, if heated to sufficiently high temperatures, can be decomposed by heat. Hydrocarbons, including polystyrene, polyethylene and styrene copolymers, will burn readily, as will cellulose nitrate, which is the most flammable of the common plastics. Chlorine and fluorine containing materials usually do not support combustion. Some plastics, including phenolics and polyesters, which will not support combustion are often reinforced with materials that will. The flammable reinforcements can be made flame resistant, to varying degrees, by the incorporation of flame retardents.

Aircraft pulley used in aircraft to support and guide control cables are required to be free of any after-glow when removed from an igniting flame. The pulley shown being tested here is made of Micarta, Westinghouse's cotton-reinforced, phenolic laminate. The plastic is self extinguishing, and hot embers disappear within a few seconds.

Ureas, melamines, nylon, phenolics and polyesters do not support combustion and are self-extinguishing. Polystyrene, polyethylene and vinyls burn slowly, and the acrylics and most cellulosics burn about like medium density wood.

Other Properties

Electrical Properties — Practically all plastics have excellent dielectric properties. Perhaps this property more than any other one characteristic has been most responsible for the use and acceptance of many plastics. While plastics do compete with porcelain, rubber and other dielectric materials in ordinary electrical applications, plastics are superior for use with high frequencies.

Appearance—Plastics in themselves present pleasing appearances, and it is not necessary to add finishes to them to provide eye-appeal. Molded materials tend to take on the surface finish of the mold; thus, most are extremely smooth on the outer surfaces.

In the case of those plastics which are available in colors, the color is inherent in the material and is, therefore, permanent and not limited to the surface.

When metallic appearances are desired, it is possible to add thin coatings of metal by electroplating, metal spraying or vacuum metallizing.

Heat Conductivity—The heat conductivity of plastics is extremely low. This helps to explain why materials of this class have a "warm" feel to the touch and thus make good handles, hand wheels, and similar parts. Likewise, tool housings and handles, and handles of utensils take advantage of low heat transfer rates to keep the handles relatively cool in relation to the item to which they are fastened.

Among the other properties of some of the plastics, one is of importance in some applications. The acrylics and polyesters are capable of being produced with complete transparency. In fact, the acrylics are often used as lenses for various optical devices. The acrylics and polystyrenes also have ability to bend light, and this property is used to advantage in medical and dental instruments, illuminated instrument dials, and various types of side-lighted signs.

Where Plastics Are Being Used

Plastics are being used in so many thousands of ways that a complete list of applications would require a good sized volume. However, the majority of such applications are of the type for which the materials really have no competition or in which the plastics have taken over as universally accepted materials. In most instances, these have been other nonmetallic materials, including glass, wool, cotton, porcelain, ceramics and various types of rubbers. During the past decade, though, plastics have emerged as active competitors of metals. In many cases they have supplanted metals because of their superiority in specific applications. Many applications which were reluctantly turned over to plastics during periods of metal scarcities remained with plastics when metals were again available.

Currently, we are in a period when many metals are scarce and their uses restricted. Therefore, the wise engineer will reexamine his products to see where plastics can be used. His approach should be to seek an alternate material—not a substitute. For, when plastics are properly selected and applied, there need be no apologies for their use. It is a reasonably safe prediction that many products which have never been made of plastics will soon be made of these materials. A fair percentage will never return to metals, because it will be found that the plastics are not only better for certain applications, but also much less expensive to use.

Applications shown, described and referred to in this section are not necessarily outstanding examples as far as being spectacular is concerned. Most have been well tested in service which extends back much farther than present scarcities. The most spectacular applications are those developed for the military services, and these cannot be revealed for some time. It is important to remember, however, that all military services are using large quantities of plastics in many ways. Naval experts have seen fit to predict that before many years, plastics will be used extensively in the superstructures of large ships.

Today, plastics are being used in products ranging from tiny tire valve caps up to and including military assault boats. In between we find plastics serving many industries in many ways. They are used for bearings; valves; pipes; containers of all varieties; housings for all kinds of machinery; gears for small motors as well as heavy-duty lathes; washing machine parts; automotive fenders and stone guards; and for many vital structural and auxiliary parts of aircraft. Industries served run the range of American manufacturing, including automotive, aircraft, chemical process, electrical, business machine, household appliance, and capital goods.

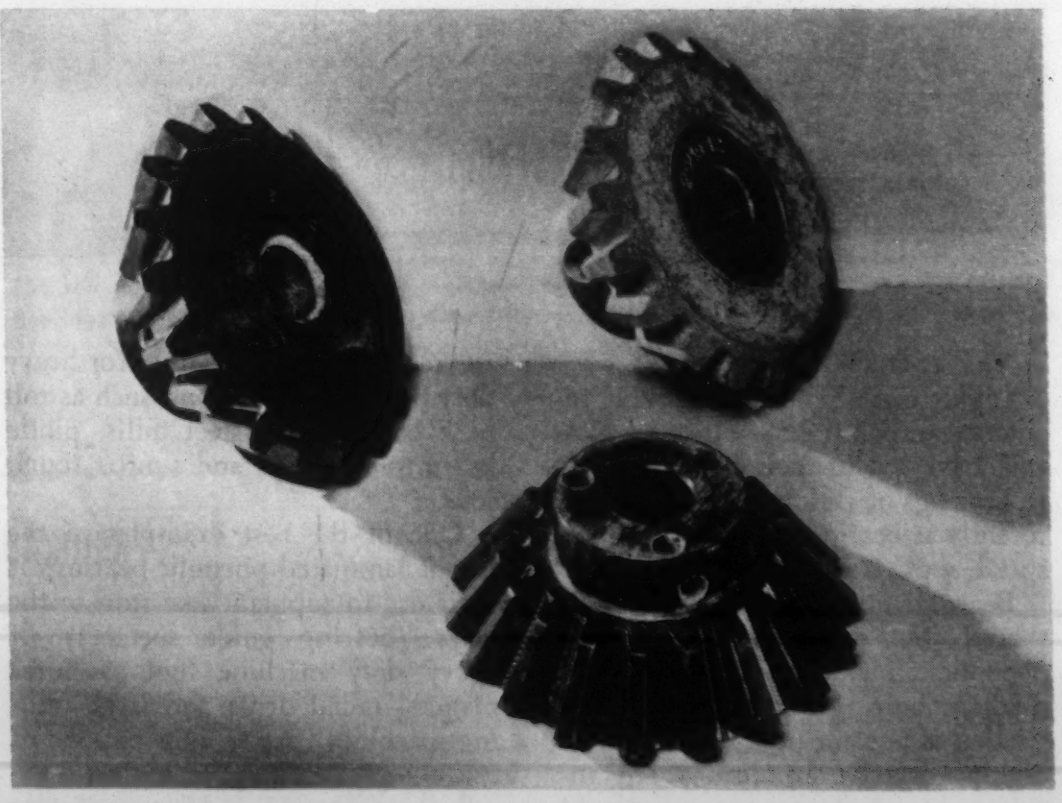
On the following pages are some interesting examples of where, how and why plastics should be considered as alternate materials for the scarce metals.

Gears

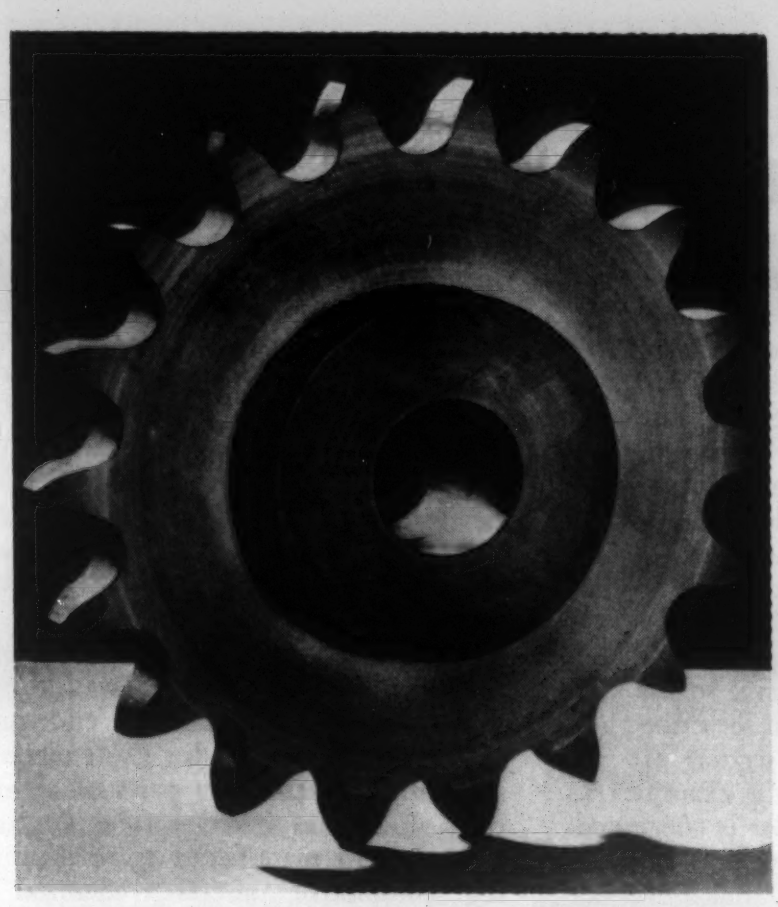
Plastics gears of all types are being widely used in many kinds of equipment. Several materials are employed, depending upon the service requirements. All, though, are selected for at least these three common qualities: high impact strength, good wear resistance and ease of lubrication. In addition, plastics gears are quiet in operation and their lightweight reduces starting torque due to low moment of inertia.

Nylon, phenolics, rubber-plastics blends and phenolic laminates are the plastic materials most frequently used to make gears. The gears are molded, milled, hobbed or blanked from strip (in the case of nylon). Whether molded or cut, extremely close tolerances can be held on tooth forms and other critical dimensions.

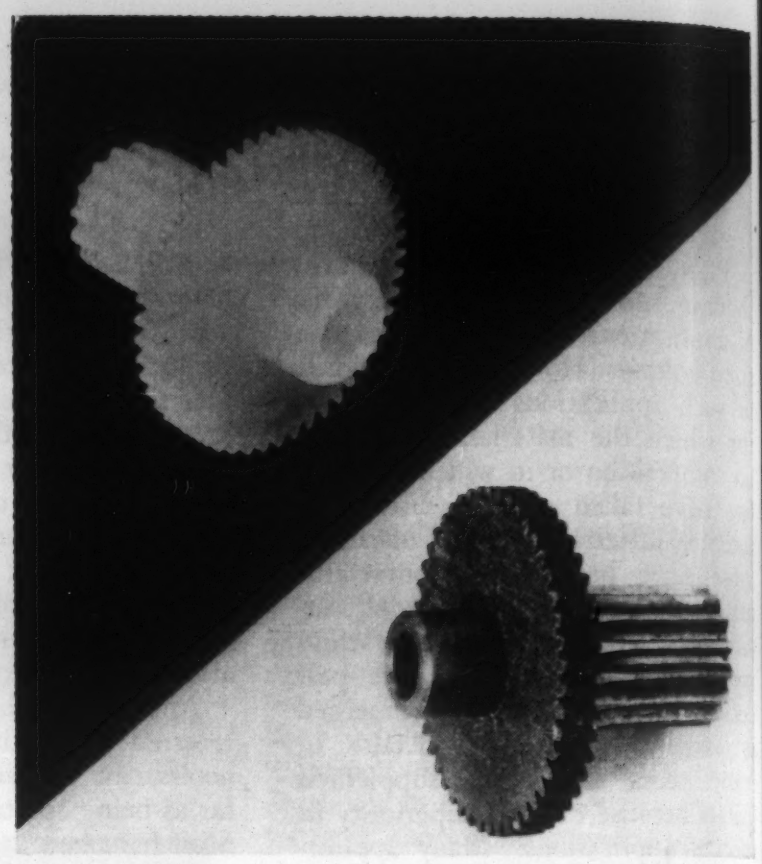
Bevel gears for driving thread advancing reels in rayon making machines must be, among other things, chemical resistant. The molded 3-in.



The Molded Durez phenolic bevel gears (left and bottom) are used in corrosive fluids in a rayon making machine. The molded gears have replaced similar shaped gears machined from a laminate which used metal inserts.



By molding this sprocket from Enrup (U. S. Rubber Co.) the need for a metal bearing was eliminated. The sprocket formerly was made of steel.



A combination metal and laminated plastics gear in the G-E oscillating fan has been replaced with a one-piece molded nylon gear, with a cost savings of 65%. Most of the saving is due to elimination of machining and assembly operations.

bevel gear now used has replaced a hobbed-laminated plastic gear which required a machined metal insert. The Durez gear is chemically inert, has a smooth natural finish and high impact strength. Close tolerances are held in molding, and finished gears are checked on a standard gear checking machine.

In a GE oscillating electric fan, the replacement of three metal gears with molded nylon gears resulted in a cost saving of 63%. Rotating at a speed of 32 rpm, with a maximum torque of 6.75 oz-in., a molded nylon worm wheel and pinion save 65% over a steel pinion and laminated plastics gear which involved hobbing, cutting and assembly operations. No machining operations are required on the molded nylon wheel and pinion. Tests show excellent wear characteristics as well as much quieter operation of the fan.

Bearings and Bearing Retainers

The frictional properties of plastics, plus their light weight, wear resistance and ability to withstand galling, have led to their increasing use in bearings of various kinds and more recently as bearing retainers for high-speed applications.

Bearing applications are largely shared by nylon and laminated phenolics. Nylon is most frequently used for bearing surfaces where lubrication is poor or nonexistant, where highly corrosive conditions are anticipated, or where abrasion would limit the life of metal bearing materials. Laminated phenolics, using linen, canvas or other strong fibers for reinforcement, are used for heavy duty bearing applications, such as roll neck bearings for steel mills, pintle bearings for ships and similar tough jobs.

One of the best examples of the use of laminated phenolic bearings is their use to supplant cast iron in the ways (bearing guide surfaces) of heavy duty machine tools such as planers, radial drills and large milling machines. After long periods of use, the plastics ways have shown excellent nonscoring and wear resistant qualities. Because of these properties, wear is negligible and cutting and scoring held to a minimum.

Laminated plastics permit higher bearing loads than cast iron and wear better. The low friction quality of the plastics surfaces, plus low heat conductivity, prevent heat from being transmitted from the bearings to the metal tables being supported.

In some applications, the laminated ways are attacked by means of plastics pins. In others, the plastics parts are joined to the underlining metal surfaces by means of adhesives.

Nylon bearings take all shapes and forms. Some are molded, others are cut from rod and tubing. Their uses range from baby buggy wheel bearings to sleeve bearings for handling

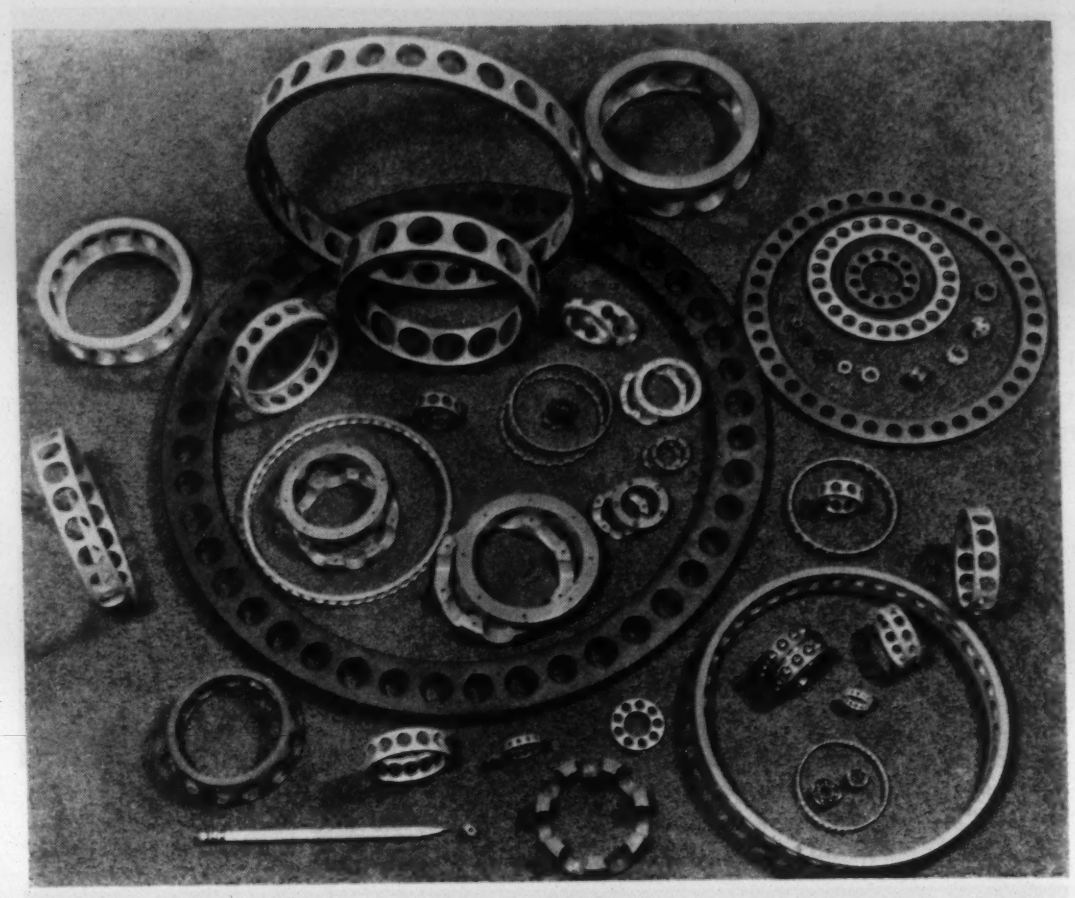
abrasive materials and others which must operate in photographic developing chemicals.

In one instance, a nylon sleeve is fitted into a bronze housing for use in a screw conveyor handling grain. The composite bearing replaces a bronze bearing with a considerable increase in service life. Because lubrication was impossible, the bronze bearings wore out within a month and could not run when covered with abrasive dust. After a 4-month period of operating 24 hr per day, seven days a week, at 14 rpm, the nylon sleeve needs no lubrication and shows no signs of wear.

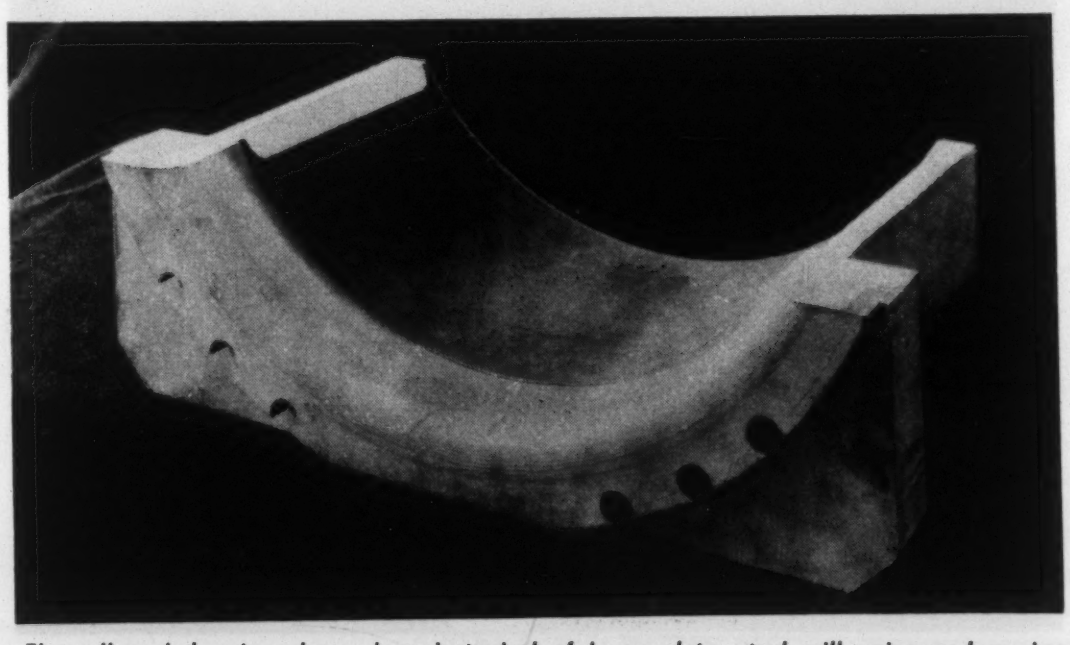
Laminated plastics are now commonly used as retainers in superprecision bearings. Bearings of this type are employed in grinding spindles, automatic lathes, wheelheads, turbo superchargers, aircraft instruments and other high-speed and precision applications where low inertia in bearings is important. The laminated phenolic materials have replaced steel and brass retainers in many instances.

Advantages of plastics in this type of work include: (1) Light weight, which results in lower starting torques and less shaft unbalance during rotation; (2) low friction, providing long service life with little or no detectable wear; (3) corrosion resistance; (4) no electrolytic action which could result when dissimilar metals are used in shaft, balls and retainers; (5) quiet operation; and (6) nongalling—will not gall or seize at low lubrication as before a film has developed during starting.

Plastics retainers range in size from less than 3/16 in. ID to as large as 34 in. OD, containing balls from 1/16 to 2 in. in dia. The maximum continuous operating temperature for laminated plastics retainers is between 250 and 275 F, with intermittent temperature up to 300 F permissible.



These are samples of sizes and types of ball bearing retainers made from Synthane's laminated plastics. Retainers of these materials are used in applications where low inertia is an important factor.

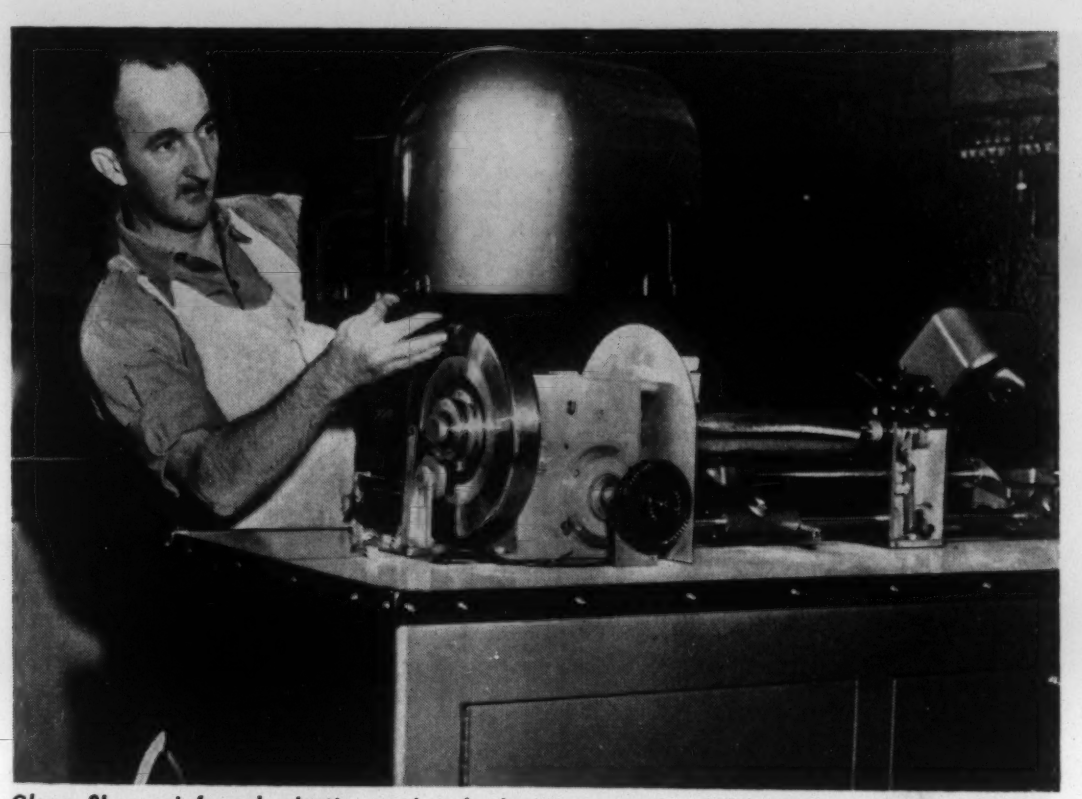


The roll neck bearing shown here is typical of heavy duty, steel mill, mine and marine bearings machined from Micarta. Simplicity of lubrication is one important advantage found in plastics bearings.

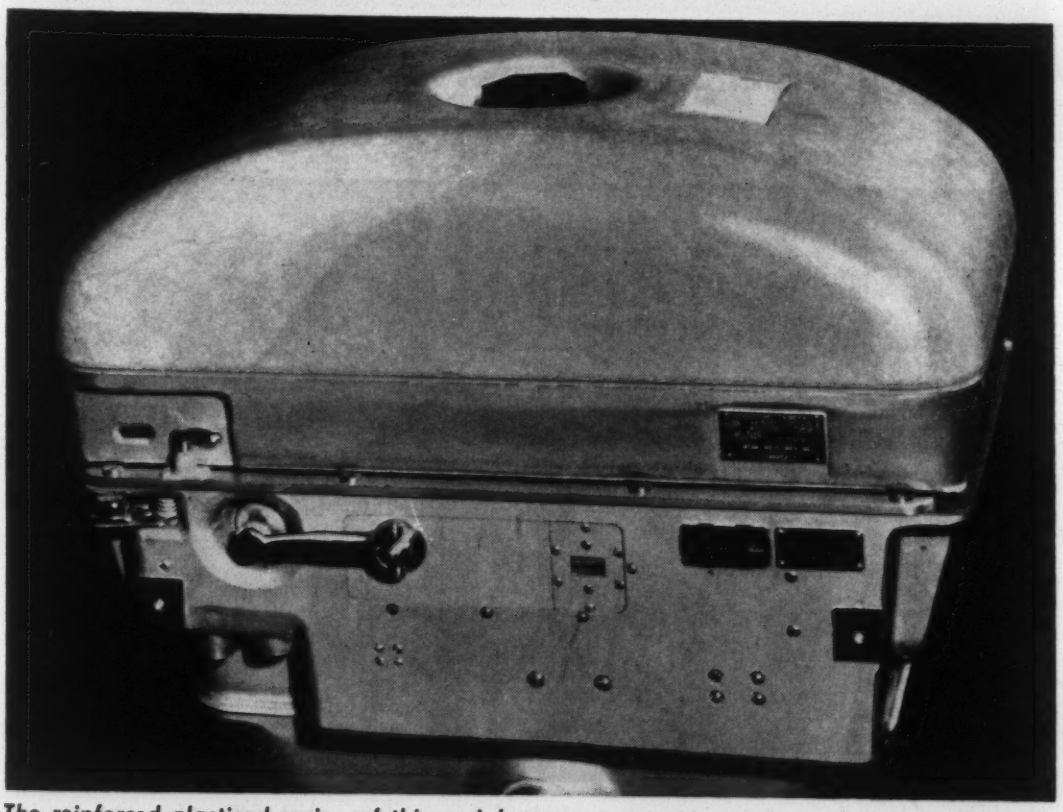
Machine and Equipment Housings

Spectacular savings in metals have been made by switching to plastics for making housings of all kinds. As in many other applications, impact resistance of plastics is one of the chief reasons for their selection. In the case of small motor-driven hand tools, the warmth and pleasant feel of plastics make them good choices. In large equipment, the excellent strength-weight ratio of plastics is important, particularly with portable machines, as is the ability to withstand considerable bumping without deformation of shape. In certain instances, the low rate of heat conductivity is of extreme importance.

Many types of plastics are used for housings. Molded products usually are made from phenolics, cellulosics or ureas. The choice depends



Glass fiber reinforced plastics replaced aluminum as the material for housings on this Fairchild electronic engraving machine. Many advantages are cited for the plastics housing, including a $10 per housing cost reduction.



The reinforced plastics housing of this aerial camera magazine must maintain a temperature differential of as much as 60 F between the inside and outside of the equipment. The plastics housing weighs almost 4 lb less than the steel housing it replaced.

upon whether or not color is desired, method of molding and other service requirements. Larger pieces of equipment utilize housings made of reinforced plastics based on polyester or phenolic resins.

Here are some examples of where plastics housings have been used to advantage:

When an electronic engraver was developed for making plastics printing plates, an aluminum housing—made of five stamped pieces—covered the machine's flywheel and small motors. Ways of reducing costs and saving aluminum were sought, so a change was made to a housing made of low-pressure molded glass fiber reinforced polyester resins.

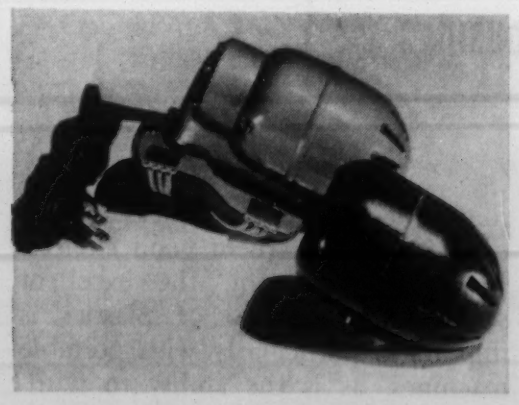
The plastics housings proved highly satisfactory. First, unit cost of housings was reduced from $30 to $20. Additional improvements cited by the user include: more uniform tolerances with a resulting reduction in rejects; practically no finishing is required on the plastics housings; the plastics housing is more resistant to denting; and, the plastics housing provides good insulation for the electrical equipment. Efficiency of the engraving unit was improved by molding a small piece of copper screening in the housing to ground out electrical interference.

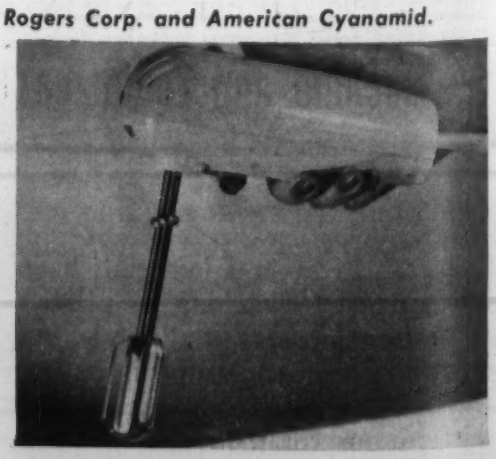
Tooling for the conversion from aluminum to plastics required only three weeks.

Three small hand electric tool and appliance applications serve to illustrate how some of the properties of plastics are used to advantage in making housings.

Toughness of cellulose acetate butyrate is needed in the housing of an electric drill where the plastics' lightness contributes to ease of application of the tool. The plastic material combining low heat conductivity and high dielectric strength protects

Cellulose acetate, a high impact phenolic and urea plastics are the materials, respectively, for these three types of hand-held electrical tools and appliances. Photographs (right to left) were supplied by Tennessee Eastman, Rogers Corp. and American Cyanamid.





the user against possible shock and any heat developed during the tool's operation.

A high impact phenolic plastics was chosen for the housing of an electric vibrator for home use. After molding, the plastics housings are spray-painted with a blue-gray pearlescent finish which preserves the appearance of the former zinc die-cast housing.

A urea resin was chosen as the housing material for a small, hand electric food mixer. The plastics met the requirements of being resistant to perspiration and food stains, lightness with strength, and good electrical insulating properties. Clear white plastics give the mixer housing a clean, sanitary look without the need of any finishing operations.

In a military application, the low heat conductivity of plastics is used to advantage in the housing for the automotive magazine of an aerial camera. The bottom panel of the magazine contains a heating element to keep the photographic film from becoming brittle at the low temperatures encountered at high altitudes. The cover is required to seal in the heat and cannot distort under the temperature differential, often as great as 60 F. Too, weight savings are important. The cover, made of glass fiber reinforced polyester plastics, weighs 1.85 lb as compared to 5.75 when made of sheet steel. Impact resistance of the cover material is also an advantage in that the cover is subject to rough usage, which would be sufficient to dent and distort most metal housings that were sufficiently light in weight to meet requirements.

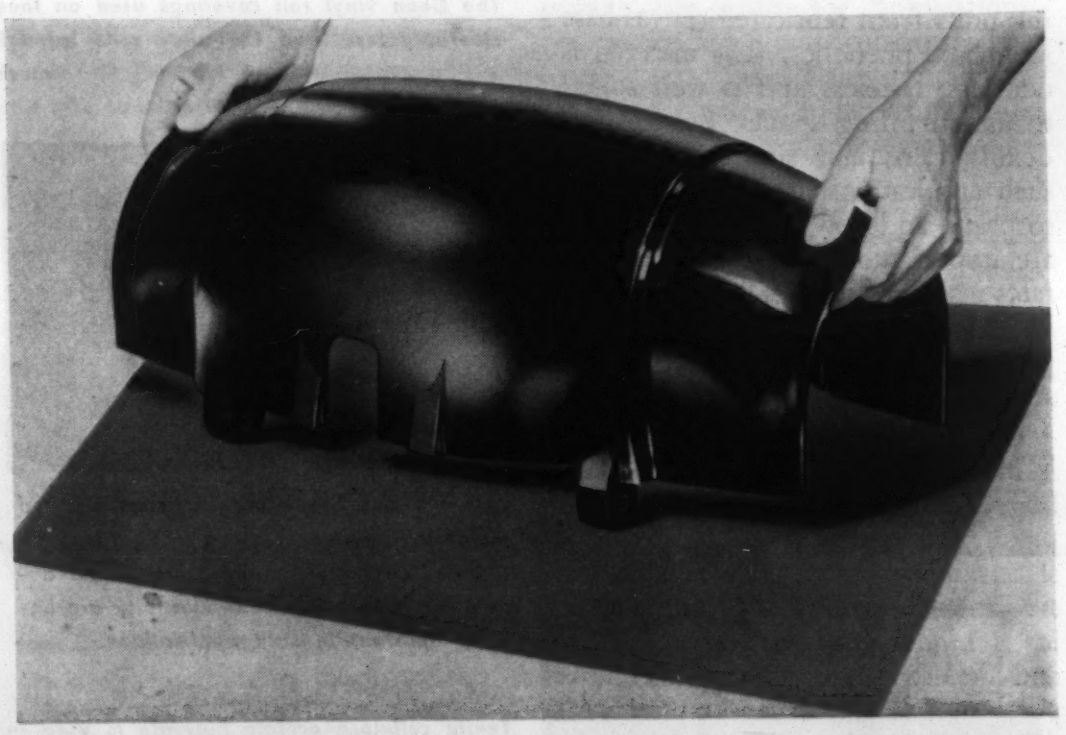
Industrial Equipment

Plastics have proved themselves in many industrial applications where operating conditions are usually far from ideal. Some typical uses are touched upon in other sections of this report and include gears, bearings, housings and many other parts. Included in this section are several other applications that will point out other potential uses for plastics.

Two parts of a stitcher for shoe repair shops have recently been shifted from cast iron and steel to a phenolic and a rubber phenolic material, respectively.

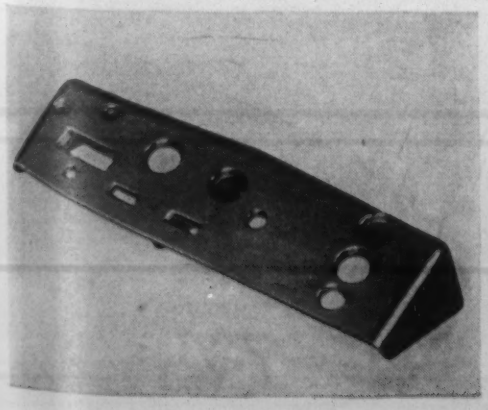
The cam cover for the machine had been cast iron, which was heavy and required considerable machining and finishing. Now a medium impact phenolic material is used and molded to shape, including heavy, integrally molded lugs for accepting hinges.

A second part is a tool holder that had been made of steel. To protect tools, the holes in the holder were lined with felt. Now, by molding the tool holder of a rubber phenolic material, a holder that is strong enough, yet safe for tool edges, is provided without any extra assembly operations. In the opinion of users, the plastics part is superior to the steel one it replaced and, in addition, is substantially lower in cost.



Phenolics plastics replaced cast iron in this cam cover for a shoe repair machine. The plastics cover, molded by Chicago Molded Products Corp., eliminates all machining and finishing formerly required.

A combination of phenolics and rubber was used in this tool holder. When made of steel, felt lining was needed in the holes of the holder to protect delicate tool edges.



An unusual application of polyvinyl chloride is in the making of applicator rolls and doctor rolls of a copying machine for designs, records, documents and the like. Reproduction of images is through the activation of unbleached aniline dye. Two vinyl covered rolls apply developing solution and four other similarly covered rolls are used in the print developing process. The applicator rolls are grooved to apply the solution uniformly by capillary action.

Rolls before the vinyl was used, were first made of brass which was nickel- and chromium-plated after grooving. Next, copper-nickel alloy tubing was used to eliminate plating. However, machining costs of the latter alloy proved excessive, due to damage to cutting tools. In looking for a means of overcoming these difficulties and others, including corrosion of base metals on plated rolls,

vinyl was adopted.

The plastic tubing and the metal core are fitted together by first steam-heating and then cooling. During cooling, the tubing shrinks onto the core to attain a mechanical hold. Machining is done in a lathe. Fountain rolls are merely turned to give a smooth surface, spiral grooves cut in doctor rolls, and grooves cut in the applicator rolls to tolerances of 0.0002 in. Extremely hard steel cutting tools are used without lubricant in machining the plastic.

Cost of machining the alloy rolls was 3.60 each; this is reduced to $.40 per roll. Resiliency and toughness of the rigid plastic tubing have just about eliminated damage in handling, and there is practically no wear in use.

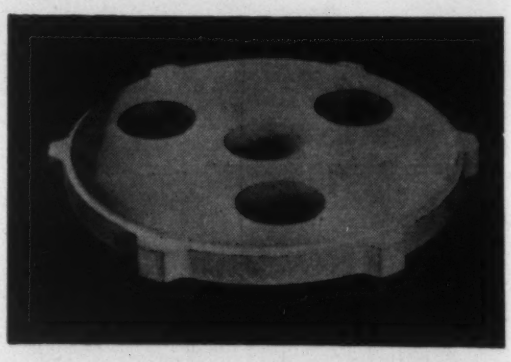
Laminated plastics are now being used extensively in parts of food handling machinery. One example is the making of automatic food filling units from fabricated canvas-base laminated phenolics. The material is odorless, tasteless and is well suited to use in filling spouts, funnels, indexing cams and similar parts. In such applications, the low water absorption and low heat conductivity are important. Also, excellent wear rates make the plastics useful in moving parts, such as the indexing and positioning devices used in filling and labeling machines.

One of the newest uses of acrylics is in the manufacture of transparent barrels, tanks and liners of electroplating machines. The plastic withstands plating temperatures and resists corrosive action of plating chemicals. Light weight, shatter resistance and dielectric strength are also important. The acrylic can be punched, drilled, stamped and sawed in fabrication and then can be cemented or heat welded for joining. Where used, acrylic plating barrels have reduced maintenance costs by as much as 90%, users report.

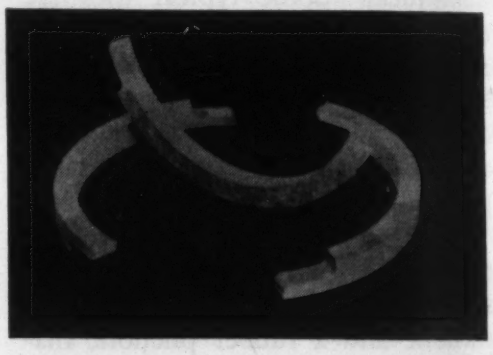
In other plating applications, a rubber plastic combination is used to mold large barrel covers in one piece. Previously, the covers were made in sections which had to be joined to make the complete unit.

The iron piston rings in some types of natural gas engines are being replaced by rings fabricated from a linen-phenolic laminate. They have been successfully used as compression rings in gas engine service. The corrosion resistance of the plastics parts enables them to withstand the corrosive products encountered. At the

The Geon vinyl roll coverings used on these rolls for a photo-copying machine cost considerably less than the alloy rolls formerly used, and withstand the alkaline solutions much better.



Taylor Fiber Corp. uses a canvas-based phenolic laminate to make this part of an automatic food filling unit. Low water absorption and low heat conductivity are important in such applications.



Also fabricated by Taylor Fiber Corp. are these piston rings for engines using natural gas as a fuel. The laminate plastics used successfully withstand the hot corrosive gases encountered.

Tenite cellulose acetate butyrate is used in rollers for portable conveyors because of its lightness and impact resistance. Before plastics took over this application, steel was used for the roller bodies.

same time, the wear rate of the plastics rings proves superior.

The toughness, lightness and impact resistance of cellulose acetate butyrate plastics is used to good advantage in the production of portable conveyors. The conveyors designed for loading and unloading cartons from trucks are made in 10-ft long sections which weigh only 31 lb. The sections are capable of handling a distributed load of 500 lb each.

Frames of the conveyors are aluminum or magnesium, and the rollers are plastics. The 2-in. dia, 10-in. long rolls are in the form of continuously extruded transparent materials. Roll heads are black molded plastic disks which are cemented into the ends of the tubes.

The plastics units have replaced steel tubing and skate wheels for this application, and rolling performance is said to be superior.

Chemical Piping and Equipment

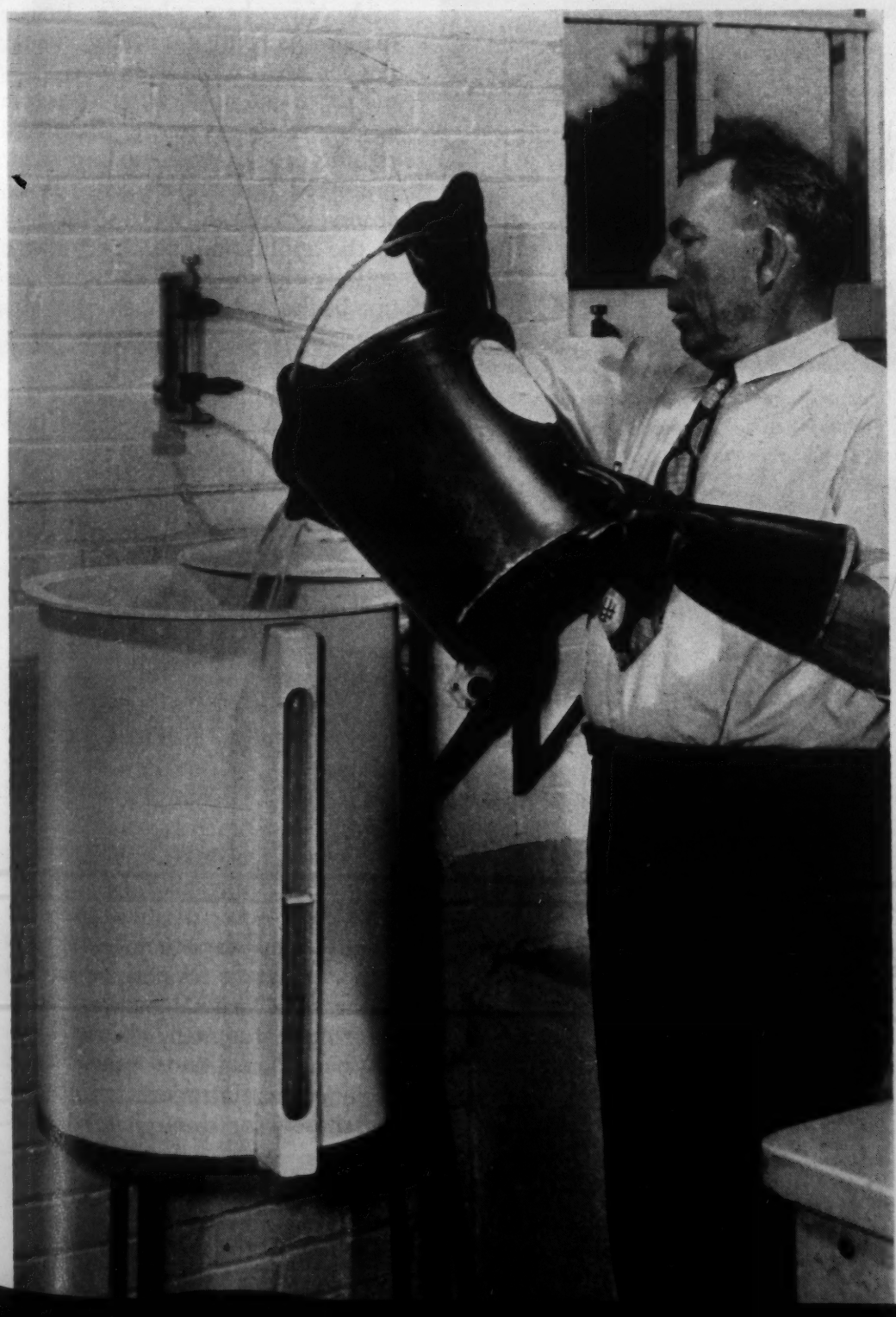
Throughout this entire manual repeated reference is made to the corrosion resistance of plastics. With this notable characteristic, it is only natural that plastics are finding ever increasing use in the process industries and other places where corrosive fluids or gases are encountered.

The fluorocarbon plastics have the greatest chemical inertness of all plastics and could be used more extensively were it not for their cost and limited availability. However, new methods of bonding these plastics to other materials will soon make them available for more general use. Some plastics are used for applications where they are almost constantly immersed in corrosive atmospheres; others are used for transporting acids and alkalies either as piping and tubing or as containers.

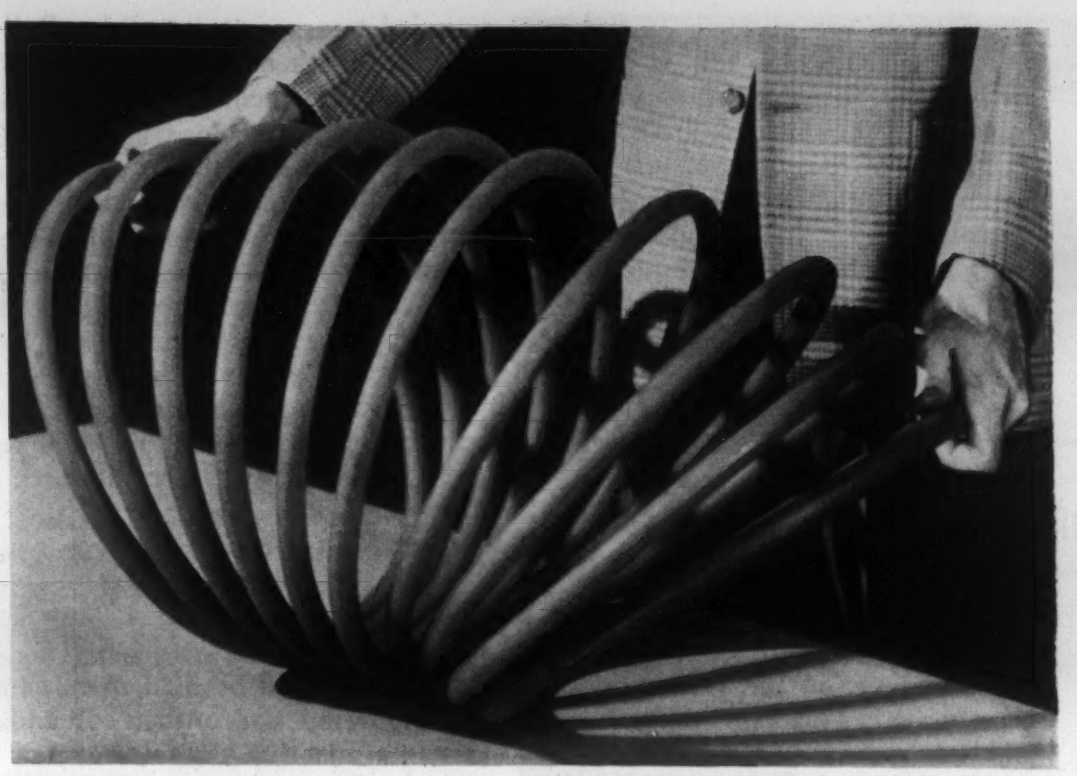
Here are some examples of the uses:

Fluorine, one of the most reactive chemicals in use today, is being used to treat water in many localities. Tanks from which the acid is fed into

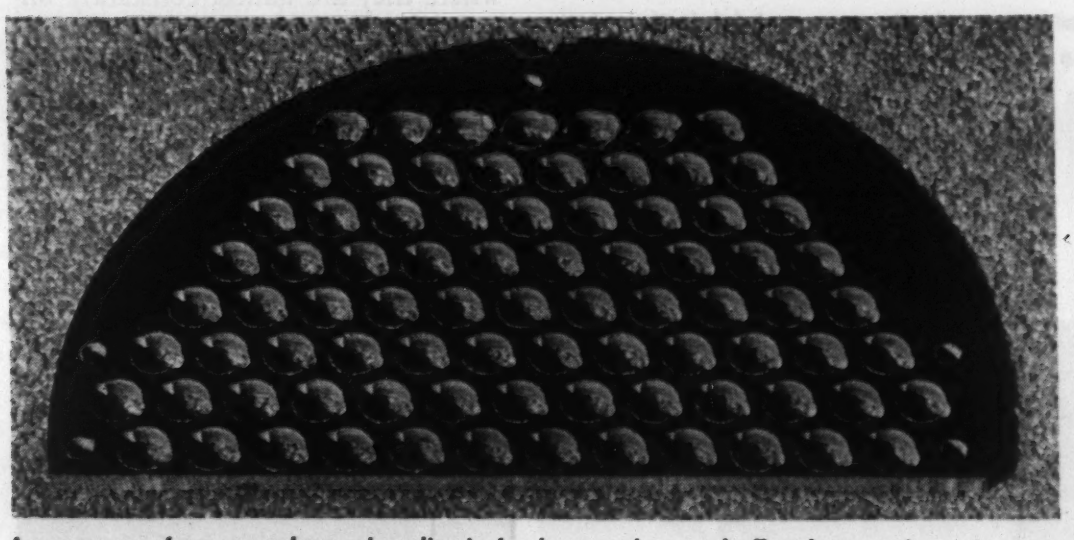
Geon rigid vinyl is used for the body and all nuts, bolts and studs for this tank which feeds hydrofluosilicic acid into a city's water system. In the course of fabrication of the tank and its accessories, machining and gas welding were employed.



Uscolite, a rubber-plastic blend, is one of several plastics that are available as pipe and fittings. Chemical resistance of plastics make them suitable for many applications in refineries and chemical process industries as replacements for the less inert metals or the more breakable nonmetallics.



Extruded rigid vinyl, such as shown here, is used extensively to conduct corrosive chemicals and as cooling coils. Geon resins are used in many products of this type.



A newer use for canvas-base phenolics is for heat exchanger baffle plates such as the one shown here, fabricated by Taylor Fiber Corp. In addition to serving as excellent dampeners, the plastics baffle plates eliminate much of the danger of electrolysis and absorb little heat.

water systems must withstand the highly corrosive action of hydrofluosilicic acid. Rigid polyvinyl chloride tanks are handling the material satisfactorily. The tanks are made by machining and gas welding the plastics. All nuts, bolts and studs for the tanks are made of the same plastics so that no metal need be used.

Ease of fabrication, coupled with excellent chemical resistance, led to the choice of vinyl for this application, which suggests that the same material will find other uses in industrial applications where stainless steel or lead equipment is now specified.

Most of the highly chemical resistant plastics are now available in the form of piping and pipe fittings for use with corrosive media. In addition to the vinyls mentioned earlier, plastic-rubber blends are also widely used where chemical intertness is essential. Some of the materials are threaded for connecting sections, others can be gas welded, and, in many cases, pipes and fittings are joined by cementing.

A canvas-base phenolic laminate material is being fabricated into baffles for heat exchangers and replacing metals in the application. Corrosion and moisture resistance, dimensional stability and a reduction in weight prompted this replacement. Plastics absorb little heat, which is important in the application, and electrolysis is entirely eliminated. The use of plastics baffles helps dampen any vibration among or within water tubes in the heat exchangers.

Pipe bushings and gaskets are among the many other plastics products used in the process industries to handle corrosive materials.

Home Appliances

Home appliances have long been leaders in the use of plastics materials. For a long time these uses were limited to decorative applications or to the housings of portable radios and the like. Now, however, plastics have taken on the tough jobs, and in many instances doing them better and for less than the metals they replace. Many parts of vacuum cleaners, refrigerators, television sets and other equipment are made of plastics and have served so well that no one has questioned their use.

Outstanding applications of plastics are to be found in home laundry equipment—both the ultra-modern automatic machines and the standby agitator-type units.

One manufacturer of an automatic washer redesigned the agitator so as to develop a spiral bladed device which was capable of increasing churning efficiency by 30%. However, to make and assemble the 22 metal parts was prohibitively costly. To salvage the design, the manufacturer turned to glass reinforced plastics. Now, with only two pieces he obtains an agitator that is equally strong, much lighter in weight and considerably more corrosion resistant.

The same manufacturer is making complete washing machine tubs from glass reinforced plastics and feels that in many ways they are superior to the metal tubs formerly used. Tubs of the same general nature are also being made for many chemical uses.

When the agitator type washing machine was introduced, aluminum was chosen for the agitator because

of its light weight. Many years ago it was recognized that a smoother surface than could be obtained on cast aluminum agitators would result in a more gentle, efficient washing action. So a molded plastics agitator was tried. Early designs combined metals and plastics, but the metals corroded while the plastics were still good.

Because of the success of the early agitators, a special phenolic plastic material was developed for this use. The material combined strength, durability and resistance to moisture and alkalies.

Spurred by the shortage of aluminum during World War II, most washing machine manufacturers adopted the plastics agitators and still retain them as the standard material.

In preparing for anticipated metal shortages more than a year ago, one maker of a tank-type vacuum cleaner investigated alternate materials for many parts. Naturally, plastics were chosen for many of the parts.

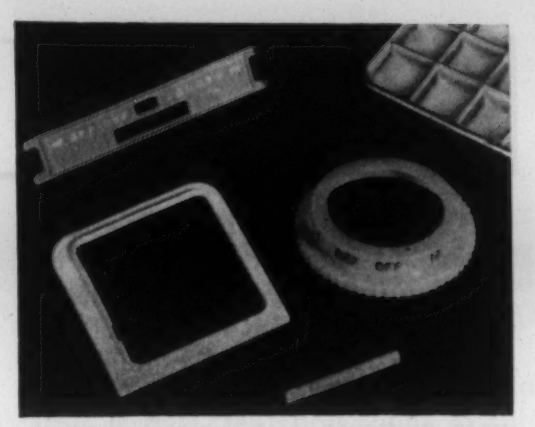
The use of plastics has worked out so well that many applications will be retained when materials supplies return to normal. One example is the air diffuser of the unit which had been an aluminum die casting. Now molded of cellulose acetate, the part has a better finish, costs 11% less, and weighs only half as much as the piece it replaced. It is molded of gray acetate to match exterior portions of the cleaner.

In the case of a handle, another supposed substitute has become the permanent material. Again replacing aluminum, the handle is now made of cellulose acetate molded over a carbon steel insert. Weight was reduced one-half, and the handle has a better appearance and feel. Because of these advantages, plus a substantial cost savings, the handle is expected to be retained.

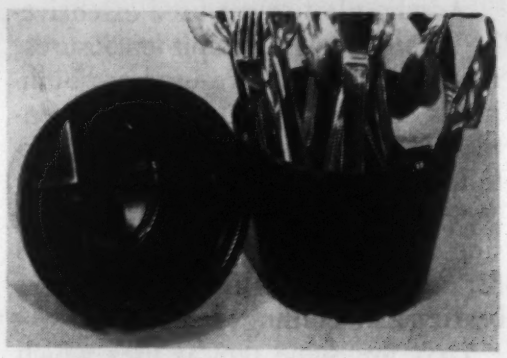
An automatic dishwashing machine had used brass screening for the silverware container. Because of bending during assembly and shipment, and scratching of silver during use, the metal has been replaced with a molded rubber-phenolic material. The compound used has exceptionally high shock resistance. Holes molded into the bottom of the container provide drainage.

Nameplates, handles and dials of various kinds also provide good fields for replacing metals with plastics. Acrylics are being used to take the place of solid metal handles on refrigerators. Other clear plastics with metallized backs are used to make attractive name plates for various types of equipment.

The examples cited are typical of many, many more which are current in the home appliance field.

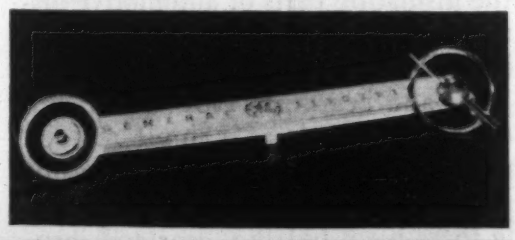


These Lustron parts are typical of the uses to which plastics are being put in modern refrigerators. In addition, striker plates, door handles and name plates are being made of plastics.



A rubber-phenolic compound is used to replace brass screening in the silverware basket of the G-E automatic dishwasher.

Erie Resistor Corp. is molding plastics parts such as these for refrigerators and television sets and then attaining metallic effects through metallizing by spray or vacuum methods. →



Shown here are two types of washing machine agitators made of plastics. At left is a molded phenolic agitator which has become almost standard on many types of washers. At the right is a new type of agitator molded of reinforced plastics. The latter agitator, made in two sections, replaced an assembly of 22 parts.

Automotive and Aircraft

Plastics have innumerable uses in automobiles and aircraft. Most of the uses fall in three categories: electrical, ornamental, and to replace glass in parts where breakage might be high. Structural uses of plastics are more widespread in aircraft than in automobiles. This is due largely to the fact that where there is a price differential, aircraft makers are willing to pay a premium for a high weight-to-strength ratio.

Acrylic plastics are used extensively in aircraft as cockpit enclosures; reinforced plastics are used for bulkheads, flooring, fire partitions, ventilating ductwork and electrical junction boxes, as well as for auxiliary fuel tanks and other equipment outside the plane. Plastics are also used for other important functions, such as bearings in landing gear struts.

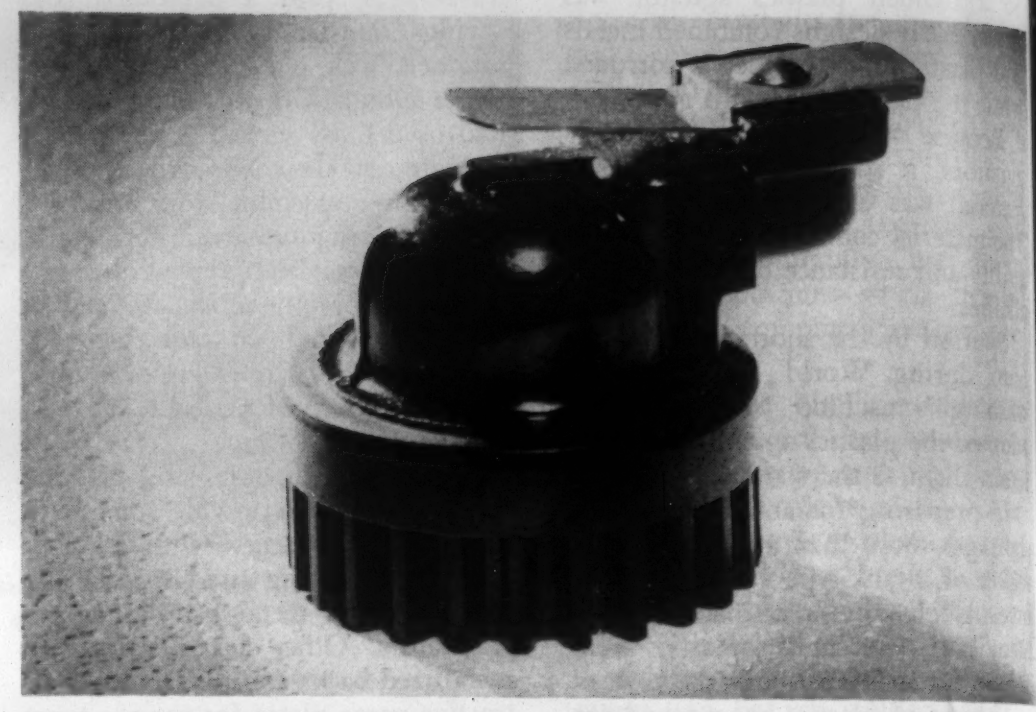
Here are some typical uses which illustrate how plastics are being used in the field of transportation:

Plastics have long been used for the insulating parts of automotive distributors. However, metals—usually bronze—have been used for rotor gears and bearings. Now a distributor rotor is made as a single molded plastic unit. The unit, molded of phenolic plastic, replaces a more costly three-piece bearing, gear and insulator unit. Not only does the new part save bronze, but it is a highly satisfactory and economical unit. Before being adopted, a prototype of the rotor was subjected to severe service tests.

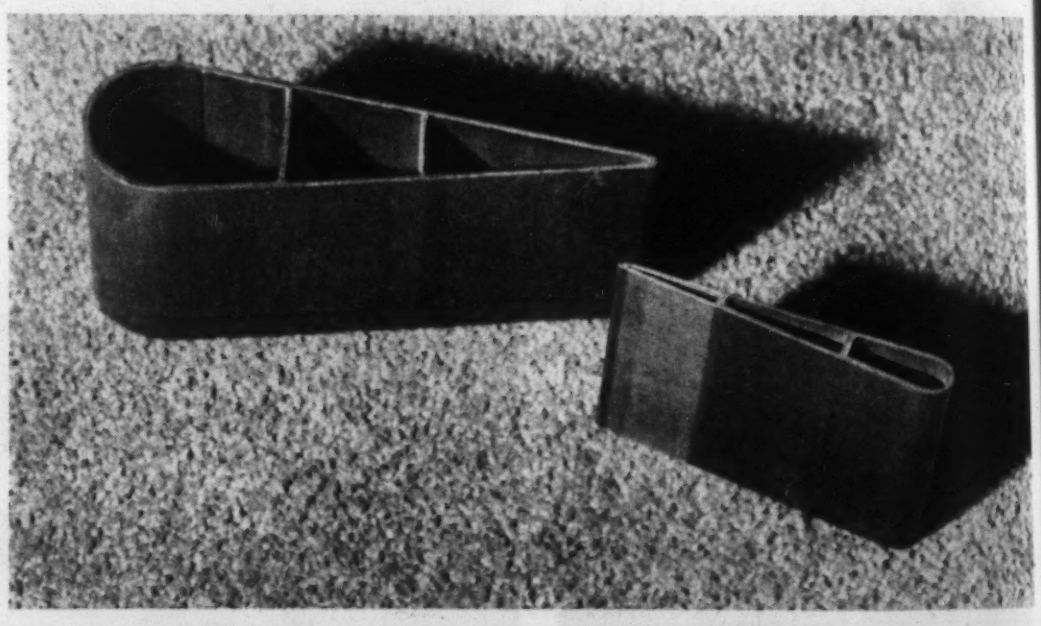
Reinforced plastics are used extensively in aircraft both military and civilian for many structural parts. Most new aircraft applications are not now being revealed so their established uses are cited. Examples shown here include a fairing for attachment to the underside of aircraft and weighing only 10 lb.

Trim tabs of airplanes are made of phenolic impregnated cloth laminates which are molded into complex shapes with integral stiffeners. Wing tips are molded of glass fiber reinforced polyesters.

Other parts made of reinforced plastics include huge radomes, stabilizer and rubber tips, and antenna masts. All must conform to precision tolerances in accordance with the standards of all aircraft components.

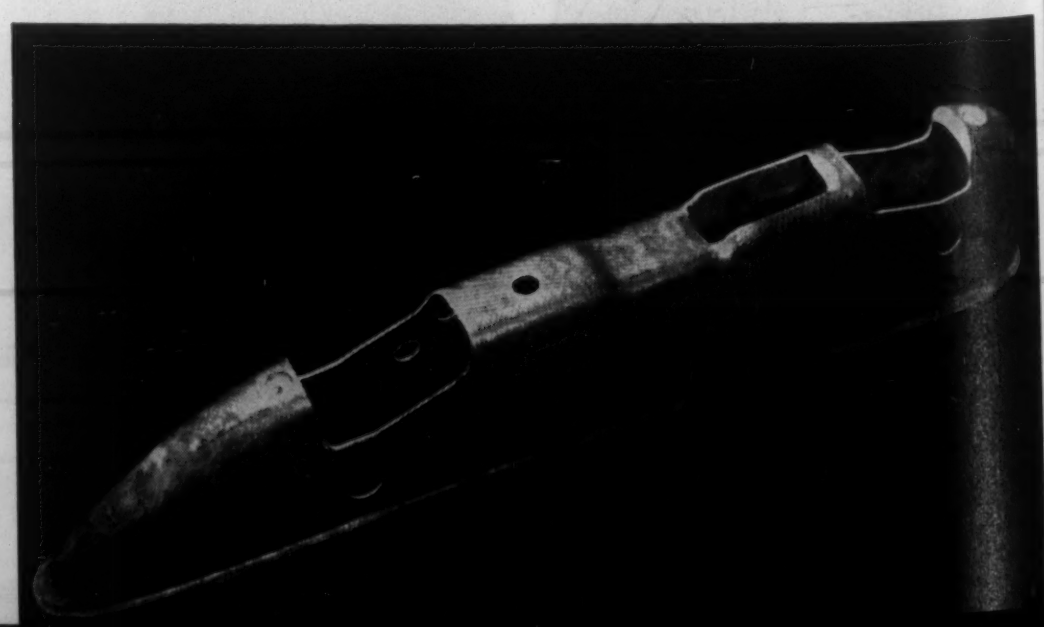


This tractor distributor rotor is molded as a single unit by Chicago Molded Products Corp. Most rotors use bronze for gears and bearings. Service tests have proved the replacement to be highly satisfactory.

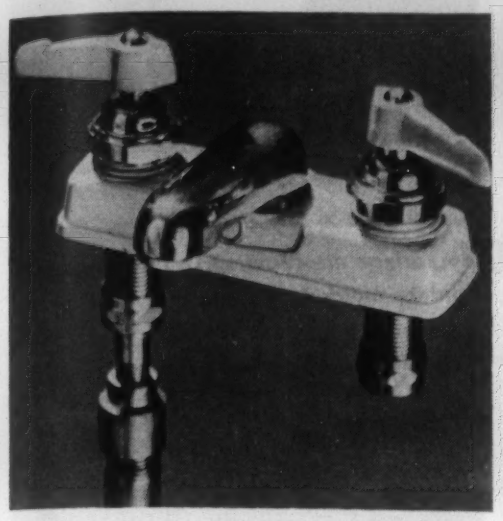


Trim tabs are among the many uses of plastics for structural parts of aircraft. These linen-phenolic laminates were molded by Taylor Fiber Corp.

Glass fiber reinforced plastics are used for many varieties of aircraft housings as well as for structural parts. High strength-to-weight ratios, good impact strength and low flammability are among the reasons plastics are chosen.

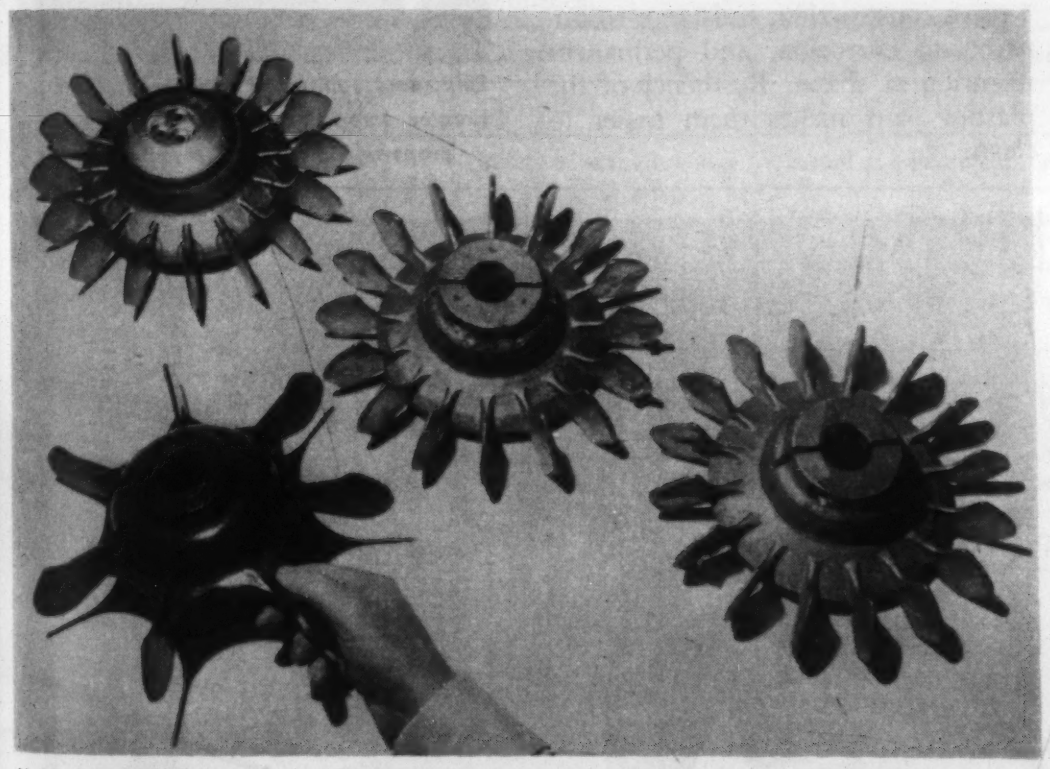


Miscellaneous Applications



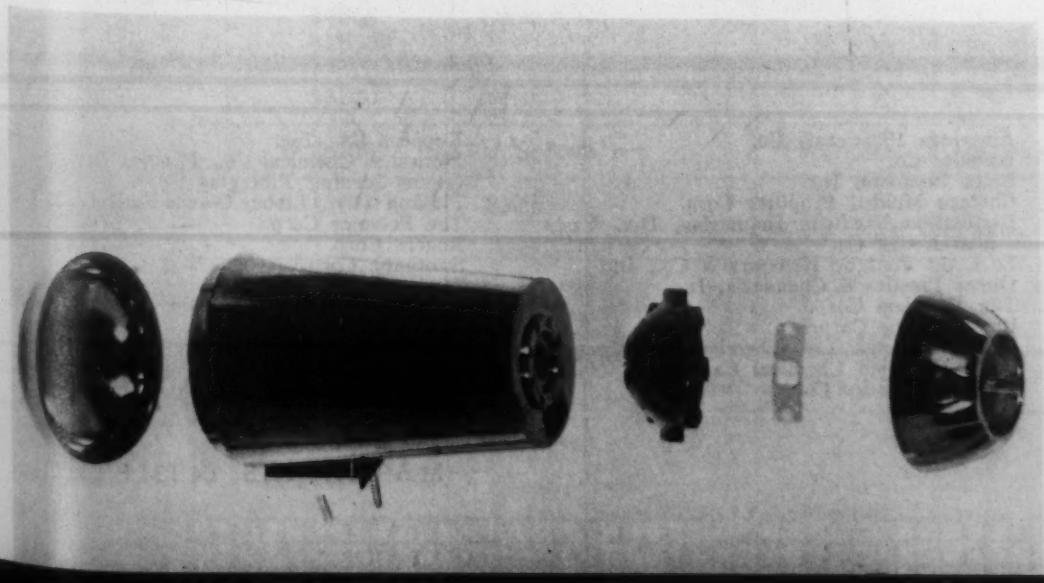
Beetle plastics are used for the escutcheons in a new line of plumbing fixtures introduced by Sears. The materials are easy to clean and resist wear, breakage and warpage.

Molded Beetle plastics shower heads are heat and water resistant.



Molded glass reinforced plastics are replacing aluminum and bronze in the Westinghouse fan-cooled, totally enclosed a.c. motors. The blowers weigh about one-third less, which means less inertia to overcome where rapid reversals are required.

By converting from metal to plastics in this salt tablet dispenser, a total of 20 parts were saved. The Durez phenolic requires no machining or finishing.



Many of the uses to which plastics are put in replacing or augmenting metals do not fall into well organized categories, but are nevertheless important and interesting.

As with other examples shown in this manual, the applications to follow are not necessarily the most spectacular in their fields. However, they do serve to suggest how imaginative materials engineers are using plastics.

Plumbing fixtures molded of ureas and melamines are now being offered by Sears Roebuck & Co. in a new line of products. Urea resins were chosen for escutcheons because they can be compression molded to provide decorative features desired. In addition, the plastics resist the destructive action of common solvents, grease and food acids.

Hot water will not soften or warp the material, which is also resistant to wear, breakage and warpage. The escutcheons are molded in a popular gray shade.

Shower heads, in the same gray shade as the escutcheons described, are being sold by Milwaukee Flush Valve Co. The melamine plastics shower heads are heat and water resistant.

Critical aluminum and bronze are being saved in making blowers for small totally enclosed fan-cooled a.c. electric motors produced by Westinghouse. The glass-reinforced polyester plastics blowers are said to have many advantages over the metal blowers being replaced. Advantages include chemical inertness of the plastics, which often work under corrosive conditions in refineries, chemical plants and process industries.

The plastics blower weighs about one-third that of its metal predecessors, resulting in a reduction in inertia —important where rapid reversals are required. The blowers have successfully passed overspeed tests at four times normal speed, and are now being used on 5- and 7 1/2-hp, 1750 rpm motors.

An unusual plastics product is a polystyrene paper towel holder that is molded to provide built-in tension and thereby eliminate the need for springs in the products. The heat resistant plastics are used so the holder can be located anywhere in a home

with no loss in strength. Currently, the holders are molded in both red and white plastics.

The spring-like action of the holder is obtained by making a molding that is slightly bowed at the outer edges. The center of the back piece is cross-ribbed, and the outer 3 in. on each side have single ribs which decrease in thickness as they near the edge. Arms of the holder are so constructed that they can fold in. When opened outward to slightly more than a right angle, a turned edge meets the bowed back piece and stops, holding the towel roll properly. To insert or remove a towel roll, added pressure makes tension of the back piece yield so the act can be accomplished easily. When pressure is released, the back piece springs into normal shape again.

In the manufacture of salt tablet dispensers, the switch from metals to phenolic plastics resulted in a much more simplified product that is easy to assemble and simple to service. Previously, the dispenser was assembled from 29 parts, all but four of which were metal. Twenty parts were eliminated in the redesign, leaving only four molded phenolic parts, one metal spring clip, one metal attachment bracket and two screws. The reduction in parts, of course, reduced the required assembly operations.

The metal cylinder used in the original device required more than a dozen machining operations, and the metal cover had to be stamped, punched and painted. These operations are not necessary with the molded plastics parts.

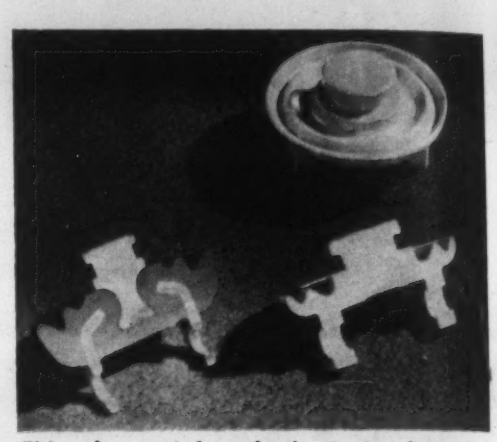
Large quantities of plastics pipe are used in chemical process industries, but there are many other important uses of plastics pipe, where portability as well as water and chemical resistance are important.

Cellulose acetate butyrate is extruded into tubing for use as irrigation piping on many Western farms. The light weight and tough tubing can be moved quickly from location to location and easily distributed along an irrigation ditch from a moving truck. Weather resistance of the plastics is improved by use of an ultra-violet inhibitor. The tubes are made in a variety of sizes and bends, and are economically advantageous in installation and maintenance.

The development of methods to make compression molded parts of glass fiber reinforced plastics resulted in the simplification of an electrical insulator, which formerly required three metal inserts to be molded into the plastics then used. Elimination of metal, which had been necessary for reinforcement, gives the insulator better electrical properties. The glass fibers are evenly distributed throughout the molding, so impact strength is uniform.

The light weight and strength of reinforced plastics is proving a boon to masons through use of the material to mold mortar pans. Steel pans, formerly produced, weighed 18 lb as compared to 4 lb for the plastics pans. Other advantages include—1-piece construction, resistance to impact and corrosion, and permanent retention of shape. Resiliency of the plastics pans makes them easier to clean.

No springs are required in this paper towel holder molded of Koppers polystyrene. Tension is molded into the back of the holder, which holds the arms in place.



This glass reinforced plastic insulator has greater impact strength, better electrical properties than former molded part.

Irrigation piping as well as other piping and tubing or drainage work of other kinds are being made of plastics. Here Tenite tubing is being distributed along an irrigation ditch.

Credits and Acknowledgments

The author is indebted to the following companies and organizations for the information and guidance necessary to prepare this manual:

DeBell & Richardson (plastics consultants)
Society of The Plastics Industry, Inc.
American Cyanamid Co.
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Bakelite Co.
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Chicago Molded Products Corp.
Distillation Products Industries, Div. Eastman Kodak Co.
E. I. du Pont de Nemours & Co., Inc.
Durez Plastics & Chemicals, Inc.
The Dynakon Corp.
Erie Resistor Corp.
General Electric Co., Chemical Div.
B. F. Goodrich Chemical Co.
Hercules Powder Co.
Koppers Co., Inc.
Monsanto Chemical Co., Plastics Div.
Owens-Corning Fiberglas Corp.
Plaskon Div., Libbey-Owens-Ford Glass Co.
The Polymer Corp.
Rogers Corp.
Synthane Corp.
Taylor Fiber Co.
Tennessee Eastman Co., Div. Eastman Kodak Co.
United States Gasket Co.
United States Rubber Co.
Westinghouse Electric Corp.

Materials Engineering File Facts

NUMBER 222
February 1952

MATERIALS:
Steel

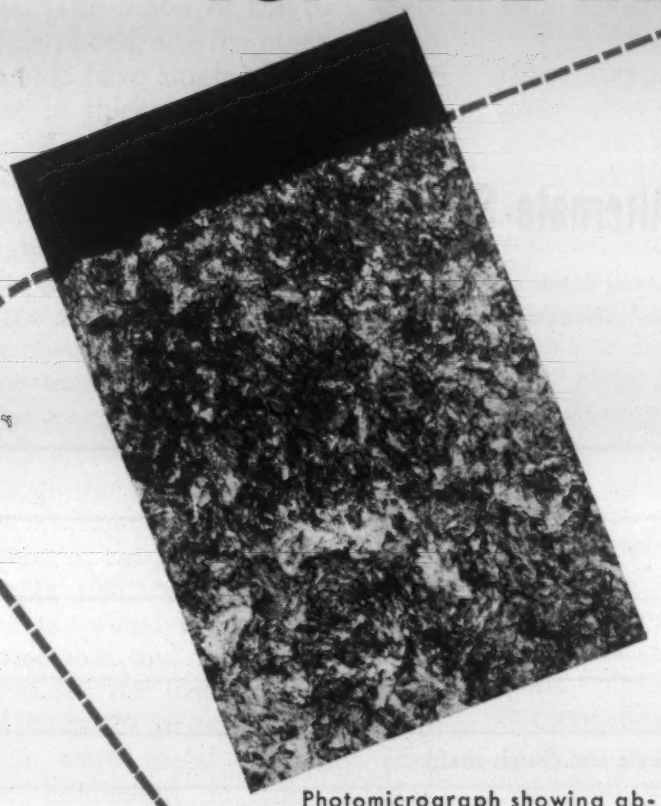
Boron Treated Types of Alternate Steels

Because of the critical shortages of a number of alloying elements, boron steels are becoming increasingly important as substitutes for the more highly alloyed grades. The following table indicates some of the applications in which boron steels have substituted successfully for more common standard steels.

Standard Grade	Boron Grade	Producer or Consumer	Application History
1321	14B26M	U. S. Steel Copperweld	Core wire for electric cables
1340	14B45	Republic Bethlehem	——
1345	14B46	Bethlehem	——
2345	86B45	Caterpillar	6 to 7-in. axle and clutch shafts
3140	14B35	Caterpillar	Spec. 150,000 tensile str., max. 1¼-in. bolts and cap screws
3145	13B50	International Harvester	Tested and found satisfactory
3310	43B10	U. S. Steel Pratt-Whitney	Aircraft gears, shafts, pinions
3316	43B17 94B20	U. S. Steel Caterpillar	Truck and tractor gears, shafts, pinions
3322	94B22	Bethlehem	——
4042	14B45	U. S. Steel	Ring gears, steering arms, structural tubing
4047	14B50	U. S. Steel	Propeller blades
4063	14B66	Caterpillar	Axle shafts, coil springs, leaf springs, equalizer bars
4122	86B20	U. S. Steel	——
4130	86B30 94B30	—— Republic	Forgings in automotive and aircraft industry
4135	81B35	——	AISI proposed equivalent used same as above
4140	14B35	Caterpillar	Spec. 150,000 tensile str., max. 1¼-in. bolts and cap screws
	14B45 13B40 81B40	Plomb Republic	Small gears and hand tools AISI proposed equivalent
4145	86B45 81B45	U. S. Steel	AISI proposed equivalent
4150	14B66 81B50	Deere & Co.	AISI proposed equivalent
4315	13B20	Buick	——
4317	86B15	U. S. Steel	Superkore "C", gears, shafts, pinions
4320	13B20 86B20	Buick U. S. Steel	Gears, shafts, pinions
4337	41B37 94B40	U. S. Steel Caterpillar	——

(*Continued on page 129*)

SCALE FREE—DECARB FREE Hardening for ALL Engineering Steels



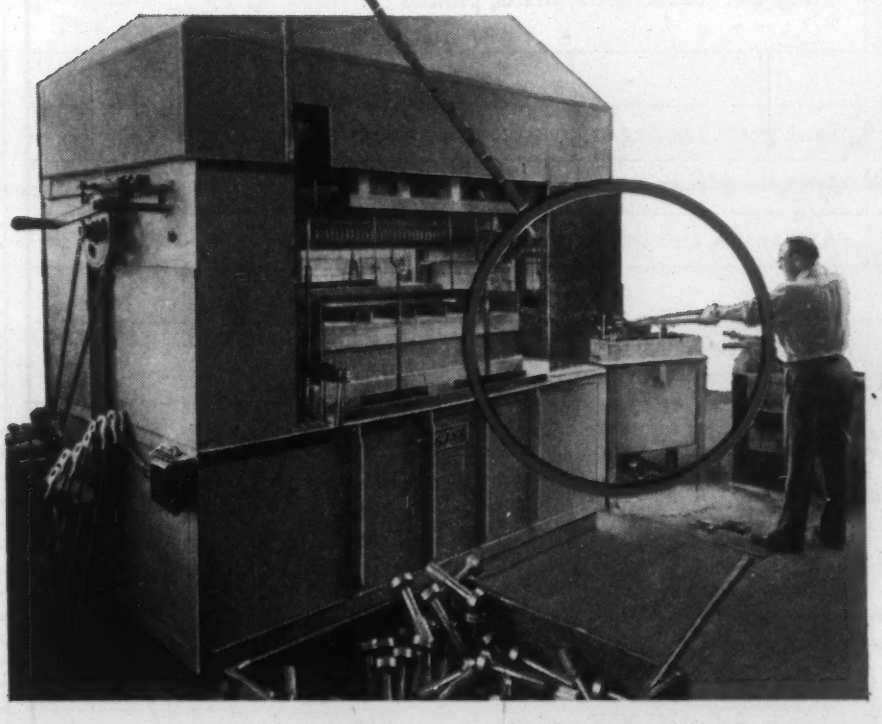
Photomicrograph showing absence of scale or decarburization in a section of S.A.E. 1085 steel (X100) neutral salt bath hardened at 1500°F. and quenched in oil. (Etched in 2% Nital.)

By its very nature the Ajax Electric Salt Bath Furnace guards against pitting, scaling, carburizing or decarburizing in the hardening of carbon, alloy, stainless and high carbon-high chromium steels in the temperature range from 1450° F. to 1950° F. The liquid neutral salt bath not only prevents these surface effects by sealing the work from air during heating, but leaves a protective film of salt on it right up to the moment of quenching. All need for "protective atmospheres," gas generating equipment and specially trained operators is eliminated.

Heating cycles are from 4 to 6 times faster than in atmosphere or radiant type furnaces, thus enabling small, relatively inexpensive salt bath equipment to handle an amazing volume of work. Heat is transferred by conduction rather than by convection or radiation, all surfaces of the work being in direct contact with the molten salt. Heating is extremely rapid and uniform. Distortion is reduced to a negligible minimum.

The unique internal heating principle of the Ajax furnace produces an automatic electrodynamic stirring action which contributes to rapid heating and assures a temperature variation of *less than 5° F.* throughout the bath.

Ajax furnaces assure low operating and maintenance costs and no skilled labor is required. Ceramic pots last 5 years or longer (many are still in use after 8 years continuous service).



Automotive spline shafts being heated in a neutral salt bath equipped with a screw-conveyor mechanism. Temperature of the work is held within 5°F. even in this relatively large bath —6 ft. long, 2 ft. wide and 2 ft. deep.

AJAX ELECTRIC COMPANY, Inc.

WORLD'S LARGEST MANUFACTURER OF ELECTRIC HEAT TREATING FURNACES EXCLUSIVELY

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SEE FOR YOURSELF!

Send or bring a sample batch of your work for salt bath hardening under actual shop conditions in the Ajax Metallurgical Service Laboratory. There is not the slightest obligation.

SELF-HEATING • SELF-CIRCULATING

AJAX HUGHES

ELECTRIC SALT BATH FURNACES

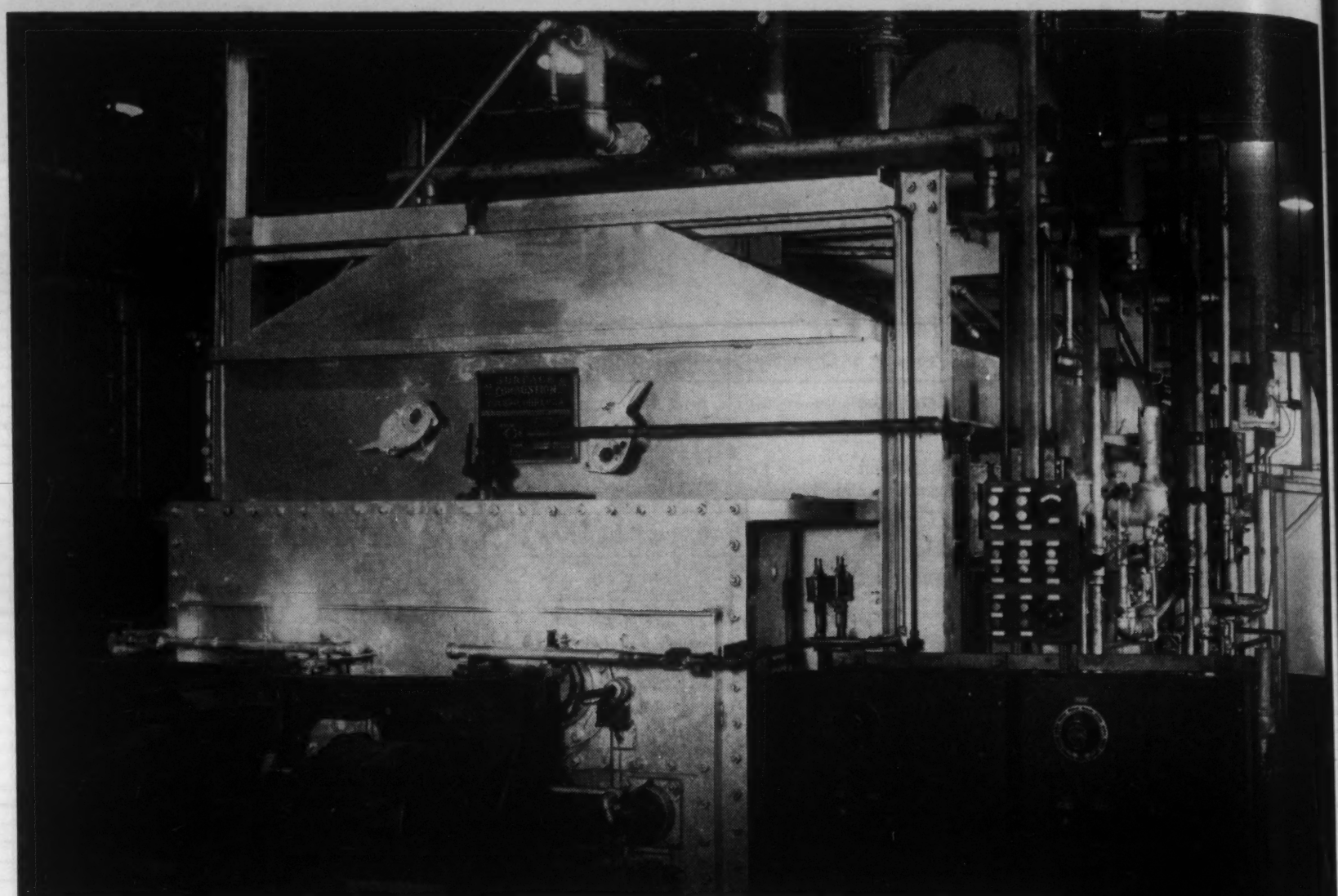
Materials Engineering File Facts

NUMBER 222 (continued)

BORON TREATED TYPES OF ALTERNATE STEELS

Standard Grade	Boron Grade	Producer or Consumer	Application History
4340	86B45 13B40 TS81B45 41B40 42B60	Caterpillar Buick U. S. Steel International Harvester	6 to 7-in. axle and clutch shafts AISI proposed equivalent Torsion bars, heavy heat springs; 0.60 C, 0.75 Mn, 0.50 Cr, 0.13% Mo
4350	94B50	Y. S. T.	0.40 to 0.50 silicon
4620	94B17	Tim.—Det.—Deere	Hypoid gears
4640	86B45	——	——
4810	43B10	U. S. Steel	——
4815	43B15 46B15M	U. S. Steel	Superkore "B" (modified manganese) heavily loaded gears, shafts, pinions, and carburized parts used in oil well drilling
4817	43B17 TS94B17	Mack Mfg.	Gas carburized gears AISI proposed equivalent
4820	43B20 46B20 86B20 TS94B20	Bethlehem U. S. Steel	Superkore "BB" AISI proposed equivalent
5140	14B45 50B46	Republic—U. S. Steel Copperweld	——
5150	50B50	——	——
5160	40B63	U. S. Steel	——
8620	14B22 40B23 50B20 80B20	Caterpillar International Harvester	 Test ingots AISI proposed equivalent
8625	80B25	——	AISI proposed equivalent
8630	80B30 14B34 14B45	 Caterpillar Wisconsin	AISI proposed equivalent
8635	80B35 14B35 14B46	 U. S. Steel Wisconsin	AISI proposed equivalent
8640	80B40 14B50 50B40	 Plomb Wisconsin	AISI proposed equivalent Test ingots
8645	80B45 14B45	 U. S. Steel	AISI proposed equivalent
8650	80B50	——	AISI proposed equivalent
8655	80B55	——	AISI proposed equivalent
8660	80B60	——	AISI proposed equivalent
9262	92B60	Wisconsin	0.50 to 0.70 silicon, 0.01 to 0.03% vanadium heavy leaf springs
9310	43B10V	Pratt-Whitney U. S. Steel	Aircraft gears and shafts Superkore "A"
9315	43B15	U. S. Steel	Superkore "AA"

Courtesy Munitions Board, Department of Defense



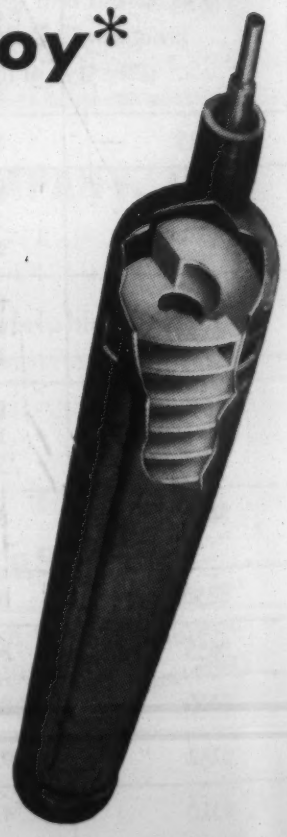
HOW SURFACE COMBUSTION HELPS CUT CARBURIZING COSTS

*with rotary retorts cast in Thermalloy**

A main part of the inside story of this Surface Combustion continuous carburizing furnace is the rotary retort we cast for it. Developed and built by Surface Combustion Corporation, these furnaces with Thermalloy retorts are operating successfully in a number of roller bearing and automotive parts plants.

To make sure small parts pass through the spiral cycle and are discharged at exactly the right time, the passage must be free from obstructions. No part can be allowed to "hang up" and carburize too deeply, since individual inspection of parts is impractical. Thanks to careful foundry practice and a unique method of cleaning castings internally, these 16′ retorts operate precisely as designed.

For retorts, furnace parts, trays, racks, pots, muffles—Thermalloy gives you more operating hours per dollar. Whatever your heat-and-abrasion-resistance problem, our engineers will help you select the right grade of Thermalloy, engineer the casting and foundry practices necessary to produce it for lowest cost service life. On your next problem, why not call in an Electro-Alloys engineer? Write Electro-Alloys Division, 2082 Taylor Street, Elyria, Ohio.



*Reg. U. S. Pat. Off.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION
ELYRIA, OHIO

New Materials and Equipment

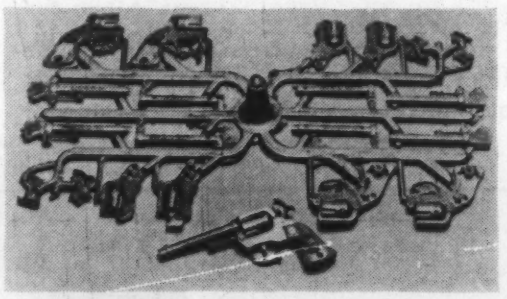
High Strength Die Steel for Elevated Temperatures Can Be Cold Hobbed

Die casting diemakers and users now have a die steel that is said to approach the hobbing ease of regular hobbing irons yet compare favorably with the high strength of the 5% chromium hot work die steels.

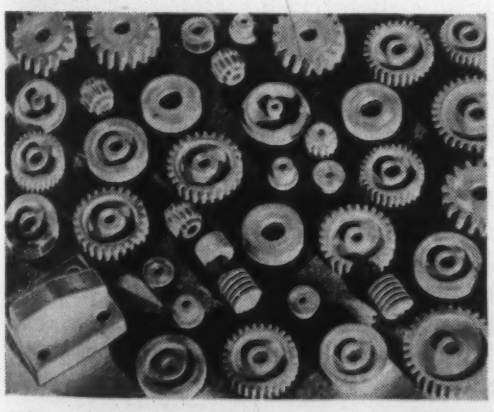
Known as Super Samson, the steel was developed by *The Carpenter Steel Co.*, Reading, Pa., primarily for applications involving die casting of aluminum and zinc. It is also being used successfully in plastic mold work involving large cavities or elevated temperatures.

The new steel is 50 to 60% as easy to hob as soft hobbing irons and provides an unusual combination of high strength and resistance to heat and abrasion. It is this unique combination of properties that is said to make it possible for diemakers to apply the proven economies of cold hobbing to more jobs, particularly duplicate dies. In addition, company metallurgists claim that the new steel offers this exclusive advantage: it will harden uniformly in dies with wall thicknesses up to at least 4 in.

Based on the present knowledge of this alloy, it is possible to predict that it will provide new opportunities for die economies on many jobs. The greatest savings will probably be found in hobbing versus machining of large or intricate cavities. It is also believed that the use of hobbed cavities will be extended, and Super Samson will permit the casting of designs not now practical to make in machined cavities.



An example of the intricate details that can be hobbed in Super Samson is found here in a single-shot zinc casting for a popular brand of toy cap pistols.



These injection molded nylon mechanical parts are now being produced economically as the result of a new, low-cost tooling method.

Injection Molded Nylon Mechanical Parts Produced by Low-Cost Tooling

Injection molded nylon mechanical parts are now being produced economically in small quantities as the result of a new, low-cost tooling method developed by Nylomatic Div. of *John A. English & Co.*, Morrisville, Pa.

Nylon often offers advantages over materials such as metal, fiber, etc., in that it wears longer, runs more quietly, has more appealing appearance, and is cheaper to produce by this new method. Almost limitless is the variety of small nylon components which can be molded—gears, gear blanks, bearings, bushings, worms, rollers, cams, wheels, valve seats, etc.

Notable savings over other methods of fabrication can be effected in quantities of one hundred to a million pieces, according to the company. Since the tooling problem has been minimized, the delay usually encountered in the building of special molds is virtually eliminated. Parts can often be delivered with this new process in two to three weeks.

It is believed that the new development will open up vast new possibilities to small and large users of mechanical components in that it is now practical to utilize the advantages of molded nylon without prohibitive tooling costs and time delays.

High-Tensile, High Impact Sheeting for Rugged Service

E1B sheet currently offered by *The Dynakon Corp.*, 5509 Hough Ave., Cleveland 3, is designed to fill the need for a high-tensile, high impact material for rugged service.

It is recommended for military use on such service parts as map cases, for structural electrical parts such as terminal strips, and for stressed chemical equipment where excellent corrosion resistance is an important factor. The extremely low water absorption of E1B is said to make it particularly applicable for out-of-door and immersed applications.

Tensile strength of the material is 20,000 psi; compressive strength, 24,000 psi; impact is 18 ft lb per in. unnotched. The sheet is claimed to be resistant to acids, salts and mild alkalis, as well as to most organic solvents. Water absorption amounts to only 0.20%.

Electrical properties of E1B include dielectric strength of 325 v per mil, arc resistance of 120 sec, power factor of 4.7. Dielectric constant is 4.7 and specific gravity is 1.50.

Sheet size currently available is 18 by 28 in. in thicknesses of 1/16, 1/8, 3/16, 1/4, 3/8 and 1/2 in. Special thicknesses from 1/32 to 1 in. are also available.

New Materials and Equipment continued

Rust Preventative Absorbs and Evaporates Moisture

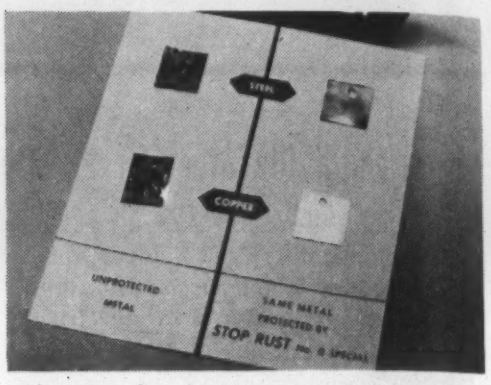
A new and improved rust preventative has been developed by the Industrial Research Institute of the University of Chattanooga in collaboration with *The Stop-Rust Co.*, P. O. Box 494, Chatanooga, Tenn.

Stop-Rust is not a petroleum-base product. It has the property of absorbing and evaporating moisture from the pores of the metal, thus overcoming the major handicap of most anti-rust preparations in that it does not seal in moisture which can form rust or corrosion pockets under the protective film. This compound absorbs such entrapped moisture, floats it out to the surface and evaporates it.

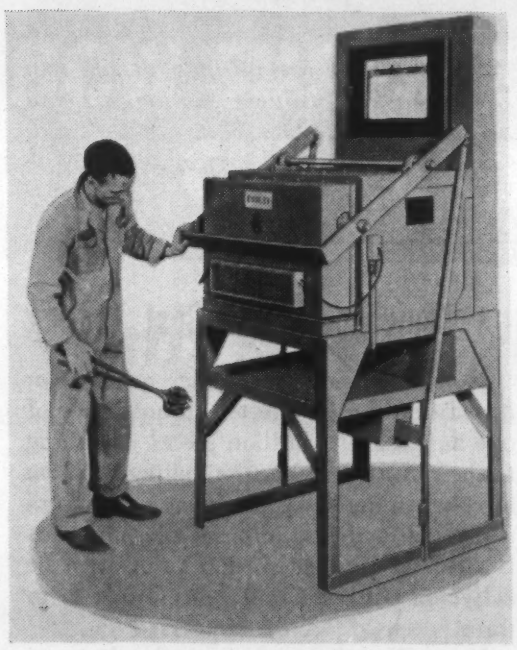
This same property prevents erosion from the condensation of atmospheric moisture. Condensation on petroleum-base rust preventatives will usually form drops of water which roll off the surface, and will soon create an erosion action that will break down the protective film.

The new preventative is of the removable type. It is said to be easily applied at room temperature by brush, dip, spray, or by wiping on. It is readily removed by such commercial solvents as Stoddard solvent or kerosene.

Advantages claimed for the new preparation are: clean; easy to handle; gives greater protection for machinery, machine parts, tools or any metal surface; when used on bearings, it does not have to be removed when the bearing is placed in use; controlled laboratory tests have shown that at the end of 840 hr of continuous exposure to salt spray, the metal protected by Stop-Rust was still in good condition while the unprotected metal was badly rusted or corroded.



After 840 hr of exposure to salt spray the metal coated with the new rust preventative remained in good condition, as shown here.



This electric box furnace is designed for operating temperatures to 2000 F.

Electric Box Furnace Useful for Large Work

The Cooley Electric Manufacturing Corp., 38 S. Shelby St., Indianapolis 7, has announced the addition of a new larger size Type BL electric box furnace to its line. Formerly available in three standard sizes with working chamber dimensions of 12 by 8 by 18 in., 12 by 8 by 24 in., and 12 by 8 by 36 in., this furnace is now offered with a chamber size of 15 by 12 by 30 in. The additional size extends the capacity of this type of furnace to handle greater production and larger units of work.

According to the company, the new furnace provides some important new advantages peculiar to this furnace alone: (1) It employs the Cooley embedded type of heating unit which protects the heavy element wire from atmospheric attack; (2) the elements formed in ceramic slabs are located in each side, the bottom, top, rear wall and the door of the furnace to give a maximum and uniform distribution of heat; (3) in addition, advantage is taken of the slab shape of elements to cause them to act as baffle walls. Unrestricted air spaces completely surround the elements and a natural air convection is thus created, further equalizing the temperatures.

In all electric furnaces the major item of maintenance is element renewal. Because of the method used in replacing elements, this cost is at a minimum in the BL furnace. The elements being in slab form are each removable as a unit through the door opening, and the time required for the entire operation is a matter of minutes. No furnace dismantling is required, and the simplicity of the process is said to result in short down time, small production loss and a minimum of labor expense.

Laminating Material for Low Pressure Moldings

A tacky low-pressure laminating material composed of glass fabric impregnated with General Electric Permafil resin has been announced by the Chemical Div. of the *General Electric Co.*, Pittsfield, Mass.

Said to permit molding layups to be made without the use of staples or other fastening devices, Permafil impregnated glass cloth is being marketed as Phenopreg LP-502. Although tacky to the touch, Permafil glass fabrics are easy to handle and do not deposit resin on the hands of the user.

Presently being used for low-pressure molding of aircraft tooling jigs and fixtures, the material is being considered for the making of auto and airplane prototypes. Molding is done at temperatures about 300 F and at pressures ranging from 15 to 75 psi. Layups can be made over wood or plaster forms and molded by the vacuum bag method. Matched metal die molding can also be used. According to the company, parts molded have high mechanical strength, good moisture and chemical resistance, and excellent electrical properties.

The #3405 Permafil resin is applied to the glass cloth on standard impregnating equipment. The degree of tack on the treated fabric can be varied. Cellophane separators can be used between sheets of the impregnated glass cloth, and it is not necessary to use polyethylene sheeting. Cotton cloth or soft papers can also be impregnated with the resin, and coatings can be obtained on high density papers or solid objects.

Two New Metals Have High Resistance to Sulfuric Acid

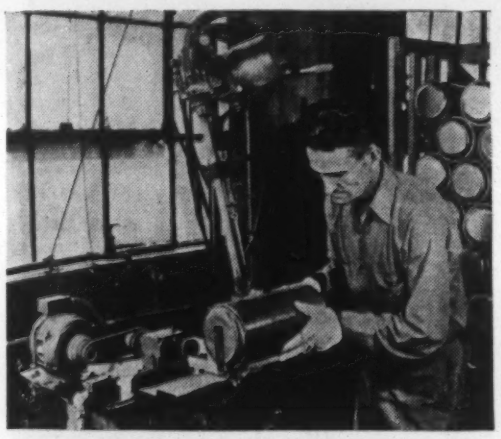
Knapp Mills, Inc., 23-15 Borden Ave., Long Island City, N. Y., are currently offering to industry two new metals; Ferrolum—lead clad steel—and Cupralum—lead clad copper—which are expected to considerably reduce the waste caused annually by sulfuric acid.

Ferrolum is made by inseparably bonding lead and steel in such a way that the finished product combines lead's unique immunity to sulfuric acid with steel's strength, while Cupralum is made by bonding lead and copper, retaining the best features of both metals, particularly lead's acid resistance and copper's high electric conductivity and heat transfer value.

In addition to the countless ways these two metals can be used to supplant inadequate materials in current use on standard equipment, it is expected that they will have widespread use throughout the burgeoning nuclear industries to prevent the escape of harmful radiation. The materials are said to be excellent for fabricating containers, tanks, vaults, shields, doors, piping and other process equipment because, in addition to their shielding value, the metals are strong, can be machined, and provide high density without the bulk of concrete.

Another promising use of lead-clad Cupralum is in the plating industry as it makes possible up to a 1000% increase in the charge which passes from the anode through the electrolyte to the work. In the heating and cooling of sulfuric acid, the product, in the form of Cupralum lead-clad copper coils, is said to be performing an outstanding job. Through the use of Cupralum it is now possible to use freon instead of water directly in the coils.

The new products combine the chemical resistance of lead to a wide range of concentrations of sulfuric acid with the physical strength of steel and copper. As a result, they will undoubtedly be the standards of the chemical industry for use with sulfuric acid.



This soldering and brazing unit is adaptable to any type of manufacturing where soldering or brazing is required.

Soldering and Brazing Unit Affects Labor and Material Savings

A new type soldering and brazing unit designed to provide a more efficient operation while effecting considerable savings in labor and materials has just been developed by the *Metallizing Co. of America*, 3520 W. Carroll Ave., Chicago 24.

Said to be adaptable to any type of manufacturing where soldering or brazing is required, the unit is completely suited to special soldering jobs as well as production runs.

The Mogul Gun, according to the manufacturer, is built to deposit lead- and tin-base solders, and also silver solder and other brazing wires, in a liquid or semi-liquid form to a part moving at constant speed under the gun nozzle. Soldering or brazing can be either intermittent or continuous at any desired rate of speed; speeds of up to 200 lineal ft of seam per min are permitted.

In operation, the unit will supply soldering material in any desired quantity which can be deposited to a pin-point location. This material, in wire form, is fed into the center of a conical flame where it is melted into a liquid or semi-liquid state, depending upon requirements, and then deposited into the seam or area being soldered or brazed.

Large Quenching Press for Forming Armor Plate

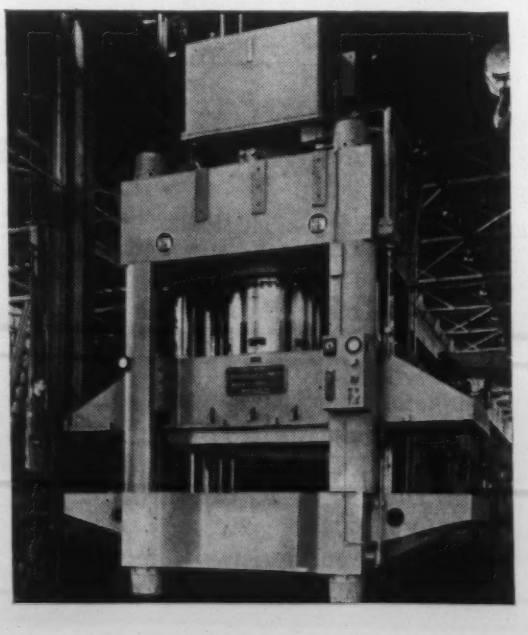
The Hydraulic Press Manufacturing Co., Mount Gilead, Ohio, has announced the H-P-M 2500-ton armor plate quenching press designed for armor plate production. The giant press is said to handle large plates from 1/2 to 2 in. thick. It has an overall bed size measuring at ends, left to right and front to back, 72 by 235 in. Clearance between rod shields, left to right and front to back is 98 by 72 in.

Hot armor plate from the hardening furnace is placed in the press and held under pressure between dies while being sprayed with cold water.

Prior to the development of this hydraulic press quenching method, the plate had to be straightened after it was cooled, employing mechanical presses and permitting only a small portion of the plate to be straightened in the press at one time. This slow and tedious process taking hours is now handled by the new unit in less than 2 min. and eliminates entirely subsequent straightening operations.

•

This giant armor plate quenching press will handle large plates from 1/2 to 2 in. thick.



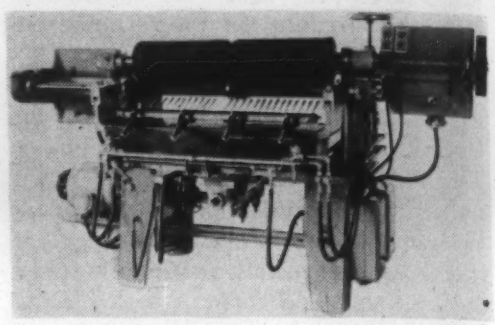
New Materials and Equipment continued

Surface Finishing Machine Speeds Production

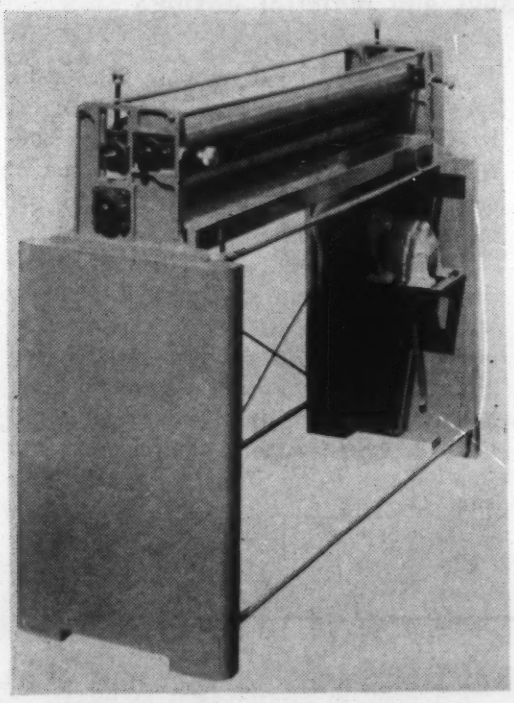
The Clair Model 208 surface finishing machine is a new development offered by *Clair Manufacturing Co.,* Olean, N. Y., designed to eliminate serious time-consuming operations in the surface finishing of spoon handles, fork handles, and similarly shaped products. Although developed for a specific use, the machine is not limited to silverware applications.

Before development of this new machine, the practice in the industry was to finish the spoon bowls on the Model 204 spoon and fork machine, remove them from the racks and place them in tote boxes, then either resort to hand finishing or reload them in another rack for finishing the handles on another machine. These procedures were excessively time-consuming and also made necessary substantial numbers of reworks because of mars and scratches due to the additional handling involved. The new model allows batches of work to be transferred as units from one holding rack to another between bowl and handle operations and, according to the manufacturer, considerably speeds up production and also reduces the number of rejects.

Operated by either 7½- or 10-hp motors, the machine has an automatic hydraulic in and out stroke which is adjustable from ¾ to 24 in. It is equipped with an air circuit which is said to provide automatic float of buffs at any predetermined uniform pressure. The standard machine is built with a safety bar across the front which controls instantaneous opening of the rolls during loading or as an emergency measure. Among a wide variety of optional features are controls which open rolls and arrest all actuation at the completion of any predetermined number of strokes from 1 to 400.



In addition to silverware, the surface finishing machine is recommended for finishing plier handles and many other curved items.



Roller Coater Designed to Save Materials and Manpower

L. R. Wallace & Co., 440 Seaton St., Los Angeles 13, has announced a new roller coater which applies paint, lacquer, adhesives and oil to any flat surface.

The new Walco coater is said to coat up to 3800 linear ft per hr and up to 850 sq ft per gal. In many instances labor savings of 50% have been shown as compared with spraying.

Model 51 offers the following features: ¼-hp motor, operates at a speed of about 64 fpm; coater rolls—3-in. steel core with ½-in. Neoprene molded and accurately ground coating, 4-in. dia, 2½-in. doctor and 4-in. pressure rolls of extra strong steel tubes ground to a perfect surface; a heavy gage steel base with full support top and bottom for perfect alignment of working parts; a wide double strand hardened and ground roller chain is used to drive all rolls, rolls run in ball bearings throughout; screw type roll adjustment which is sensitive, accurate and dependable; reservoirs are formed by the angular space between the rolls, and the space is closed at the ends by drip proof end plates of special design to eliminate dripping while machine is in motion or idle.

This industrial coater applies adhesives, lacquers, enamels and oils to plywood, sheet metal, fabrics, masonite, tar paper, fiberboard.

Plastic Material Offers High Resistance to Acids and Chemicals

A new plastic material, weighing approximately one-sixth the weight of stainless steel and with greater corrosion resistance to many chemicals, is currently being produced by *Bolta Products, Inc.,* Lawrence, Mass.

Boltaron 6200, as the material is called, is a rigid non-plasticized polyvinyl chloride of high molecular weight, based on vinyl resins such as B. F. Goodrich Chemical Co.'s Geon 404.

The scope and variety of uses of Boltaron 6200 is wide because of its ability to withstand wear, resistance to practically all chemicals, high tensile strength, light weight, high impact strength and abrasion resistance. For industrial processes where acid corrosion and oxidation below 165 F are basic problems, the new plastic will not only replace critical materials, such as stainless steel and rubber, but will substantially reduce overall operating costs.

Because it can be welded, molded, extruded, fabricated and even machined after welding, Beltaron 6200 is finding wide application in industry today, and will undoubtedly find many new and important uses in future industrial design. The following are but a few of the typical applications of the new plastic: Chemical and waste disposal pipe lines, valves and other pipe fittings; tanks and containers; anode baskets; fume and exhaust systems; stacks; plating barrels; spray nozzles; plenum chambers; filters and strainers; wire insulations; fan housings; and electrical conduit.

(More News on page 136)

N-A-X AC9115 ALLOY STEEL offers a means of reducing the use of critical alloy steels of the "stainless" type in gas turbine and similar applications. In specific cases it has replaced over half the amount of strategic material originally required, with no sacrifice of quality.

N-A-X AC9115 ALLOY STEEL has high strength and toughness values at temperatures ranging from −70° F. to +1,000° F. It can be readily cold formed into the most difficult shapes; its response to welding by any process is excellent. It must, however, be suitably coated for protection against cold or hot corrosion.

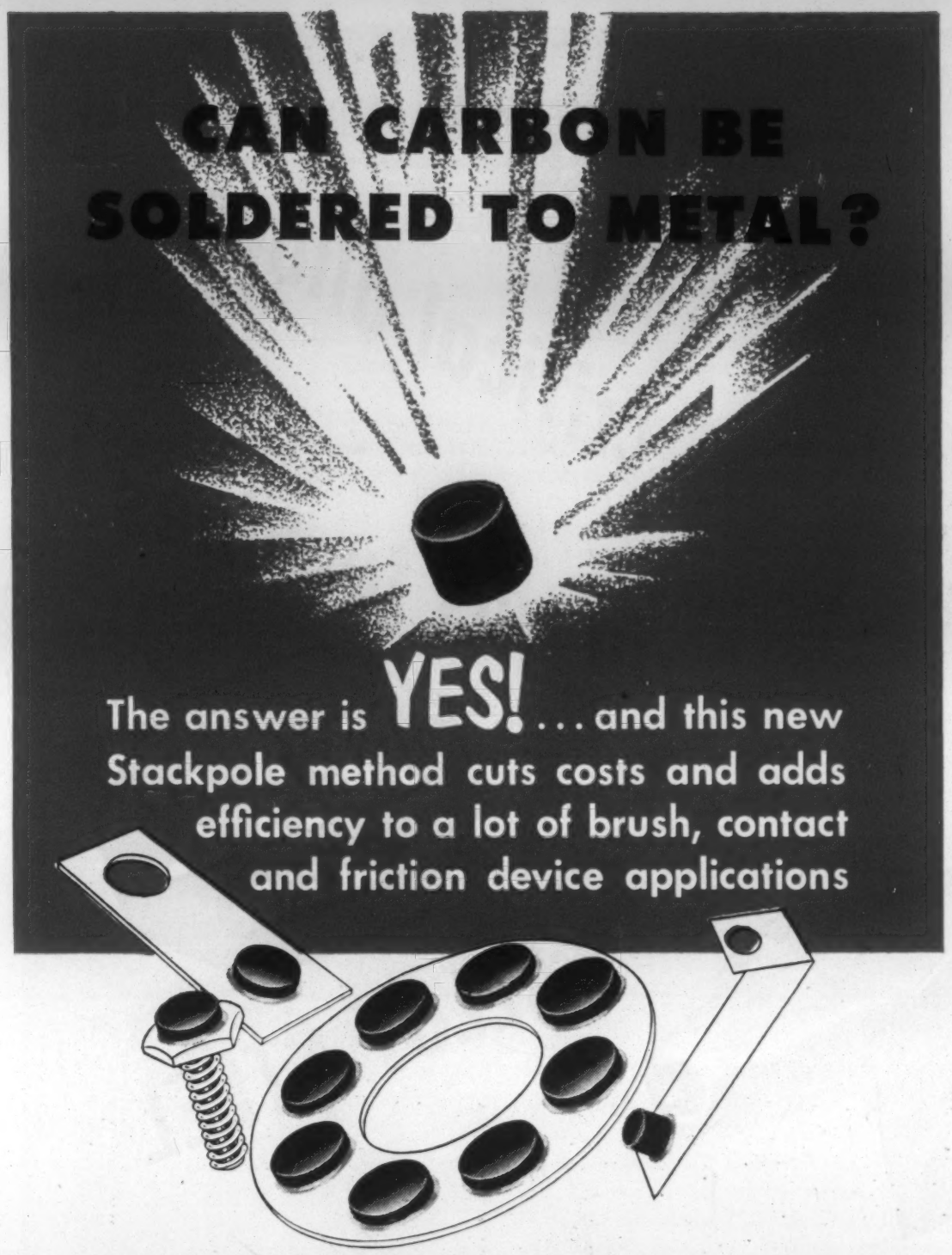
Investigate the outstanding properties and characteristics of N-A-X AC9115 ALLOY STEEL and, through its use, conserve the critical material so necessary to our nation.

It's your SCRAP that makes your STEEL
Keep it moving to your scrap dealer

GREAT LAKES STEEL CORPORATION

N-A-X Alloy Division • Ecorse, Detroit 29, Michigan

NATIONAL STEEL CORPORATION



Now Stackpole can solder carbon brushes, contacts or friction devices directly to their metal supports!

Carbon brushes, for instance, can be silver soldered to leaf springs, thus eliminating brush holders and shunts. Carbon contacts can be soldered directly to metal arms. Carbon friction discs can be soldered directly to metal backing plates—and so on through an interesting range of possibilities. You gain all of the advantages of carbon—*without the need for costly fixtures for bolting or clamping it in place!* There are some limitations on size. Send details of your application for recommendation by Stackpole engineers.

STACKPOLE CARBON COMPANY, St. Marys, Pa.

STACKPOLE

Everything in Carbon but Diamonds

New Materials and Equipment

Stainless Steel Coating Offers New Approach to Severe Corrosion Problems

A new protective coating consisting of actual stainless steel reduced by a new process to a microscopically fine form (flakes) and combined with vinyl plastics to form a quick drying liquid that is said to give a surface of actual stainless steel in coating form to protect against rust and corrosion has been announced by *Slip-On, Inc.*, 401 Broadway, New York 13.

According to the company, metals, wood, composition board and concrete can be given the permanence of the metal itself with the new coating. It offers, too, impermeability to moisture, of type 18/8 No. 302 stainless steel, in easy to apply form. Liquid stainless steel can be sprayed, brushed or dipped.

The metal is present in the form of flakes which overlap and interlock as the coating dries, thereby presenting an almost continuous barrier of stainless steel to corrosive materials.

Neither the resin binder nor the stainless steel is said to change appreciably with age. The coating is in the bluish gray, non-shiny cast of stainless steel and is tack free in 5 min or less, quick drying, and can also be baked.

New Alloy for Welding and Soldering Aluminum and Zinc-Base Metals

A new alloy, which is a combination of many metals and chemicals and is said to permit the welding and soldering of aluminum and zinc-base metals without the use of flux or cleaning, has been announced by *Chemalloy Associates*, Santee, Calif.

Originally introduced as a dry bearing metal requiring no lubrication, and as a long life die metal unaffected by lead contamination, the material has become most important as a fluxless welding rod.

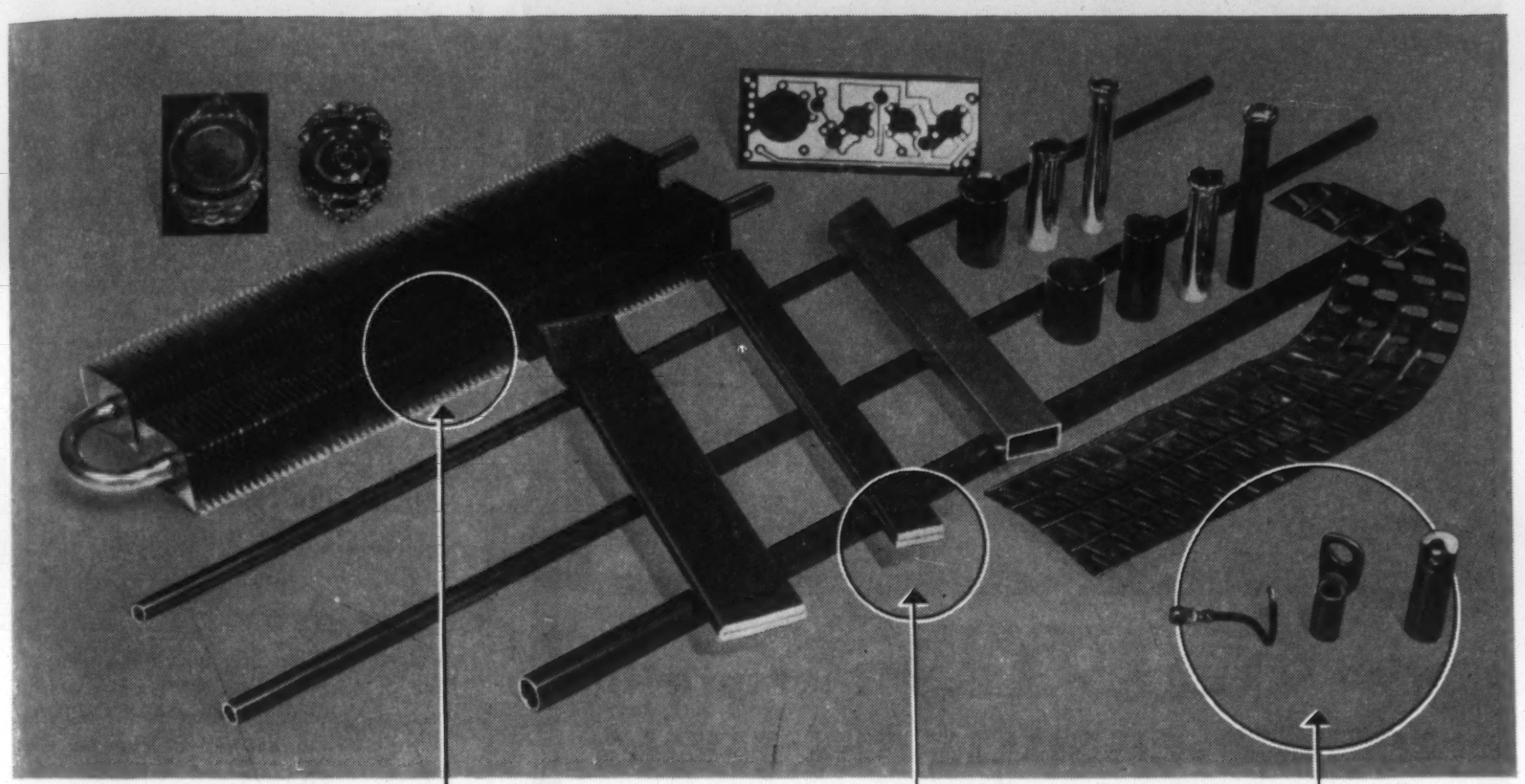
According to the manufacturer, Chemalloy welding rod offers the following advantages:

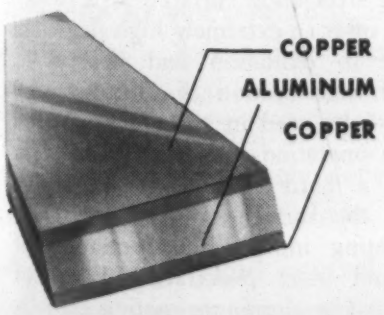
1. No flux needed.
2. No porosity.
3. Very fine grain structure.
4. No special cleaning or metal treatment for adherence.
5. Oil and oxide films do not have to be removed from metal surfaces.
6. It is both a welding and soldering bond and works with any neutral or blue

General Plate Alcuplate®

(COPPER-CLAD ALUMINUM)

Does The Work of Solid Copper . . .
Helps Conserve Critical Copper





HEAT TRANSFER SECTION — Alcuplate provides ideal fin sections. The aluminum allows proper heat transfer . . . the copper gives a copper surface for soft soldering.

ALCUPLATE BUS BARS — Bus bars can be made by folding Alcuplate providing copper on all sides. Rectangular wave guide can have a thin layer of copper on the inside or outside.

ALCUPLATE TERMINALS— Small terminals and large pressure type connectors are formed from single Alcuplate. Allows joining of dissimilar metals, copper to copper and aluminum to aluminum.

General Plate Alcuplate (copper-clad aluminum) provides a practical solution for conserving or extending your copper allotment.

Made by permanently bonding a thin layer of critical copper to thicker, more readily available aluminum, Alcuplate has practically the same physical and electrical properties as copper plus the light weight of aluminum.

Alcuplate can be fabricated by stamping, drawing or forming. Its malleability permits its use in the manufacture of many parts from work-hardened rather than annealed or dead soft materials. The copper surface permits soft soldering.

Alcuplate is widely used in the electrical field for terminals, clips, bushings, shims and high frequency application such as wave guides. It may also be used for heat transfer assemblies, fin and tube type radiators, printed circuits, badges, costume jewelry, etc.

General Plate Alcuplate is available in sheet and strip clad on one or both sides, 8″ wide in thicknesses ⅛″ and under. Tubing and wire are also available in limited sizes.

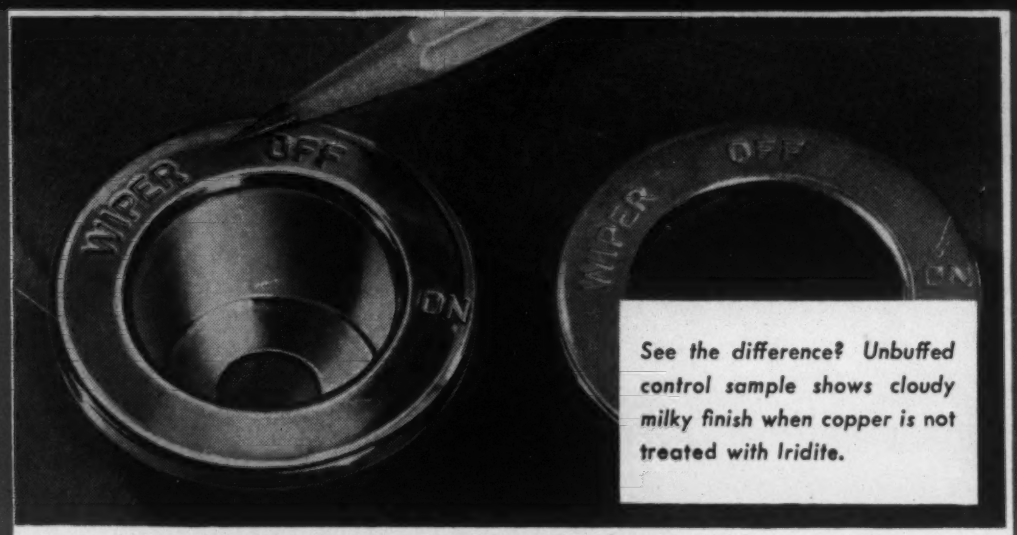
Write for Technical Data Bulletin No. 702B.

GENERAL PLATE

Division of Metals & Controls Corporation

62 FOREST STREET, ATTLEBORO, MASS.

LOOK— what you get WITHOUT BUFFING



See the difference? Unbuffed control sample shows cloudy milky finish when copper is not treated with Iridite.

with IRIDITE® Metcote in COPPER-CHROME FINISHING

This sparkling bright finish is the result of just a simple dip in Iridite Metcote between the copper and chrome plating cycles! You actually get the clear, bright appearance of copper-nickel-chrome because the Iridite treatment gives maximum brilliance and clarity to the copper undercoating.

FORGET BUFFING COSTS, PR PLATING! Once you've properly prepared the base metal . . . steel sheet or zinc casting . . . you can completely forget buffing costs because no further buffing is required! And, there is no need to resort to PR plating or extra brightener in the copper plating solution because of the chemical polishing action of Iridite Metcote. The result? A pleasing clear, sparkling bright finish that is ideal for decorative products.

PROVE IT YOURSELF! Send us samples of your product for test-processing with copper, Iridite Metcote and chrome. Then make your own inspection and tests. Once you've seen your own product treated with this Iridite finishing system you'll never go back to slower, more costly buffing for your bright finishing. Start saving money *now*—write us direct or call in your nearest Iridite representative. Look under "Plating Supplies" in your classified telephone directory.

Iridite is approved under government specifications.

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REPRESENTATIVES IN PRINCIPAL INDUSTRIAL CITIES; West Coast: L. H. BUTCHER COMPANY
Manufacturers of Iridite Finishes
for Corrosion Resistance and Paint Systems for Non-Ferrous Metals; ARP Plating Chemicals.

New Materials and Equipment

flame as well as heat from any source.
7. It can be readily machined and polished and will take plating or painting.
8. It withstands weathering, corrosion and fresh or salt water.
9. Soft solder will adhere to Chemalloy so the wires can be attached to aluminum. The wires will normally break before such a bond can be parted.

Typical uses for the welding rod are said to be found in aircraft plants, airport facilities, garages, aluminum roofing firms, aircraft and automotive maintenance and repair facilities and industrial plants.

Aluminum-Steel Alloy Offers High Resistance to Oxidation and Heat Scale

The Cambridge Wire Cloth Co., Cambridge, Md., has announced the introduction of Cambriloy-Al, a new material for fabricating woven wire conveyor belts for annealing and decorative lehrs in glass manufacturing plants.

The material is a specially developed aluminum-steel alloy surfaced wire which is said to offer an extremely high degree of resistance to oxidation and heat scale, causes of deterioration of ordinary steel conveyor belts used in such lehrs. When placed in operation, the heat of the lehr produces a hard coating of aluminum oxide on the surface of the wire. This oxide coating inhibits the formation of further and more penetrating layers of oxidation. The aluminum coating actually alloys with the steel to form an alloy surfaced wire.

According to the company, lehr belts woven from the new material have been on field tests for more than a year and results to date indicate comparable performance to the low-chromium steel alloys that had previously been in use for such belts.

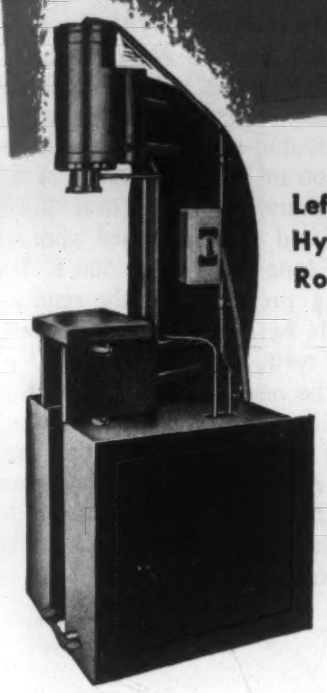
Polyester Resin Offers High Strength at High Temperatures

Development of a new polyester laminating resin which is said to withstand temperatures as high as 500 F has been announced by Naugatuck Chemical Div., *U. S. Rubber Co.*, Rockefeller Center, New York 20.

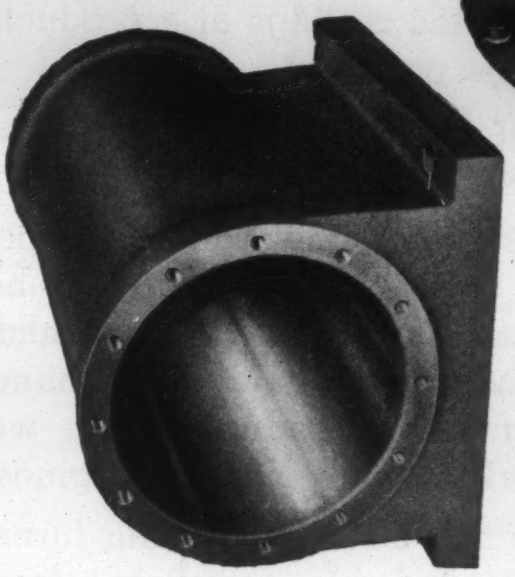
Marketed as Vibrin X-1047, the resin

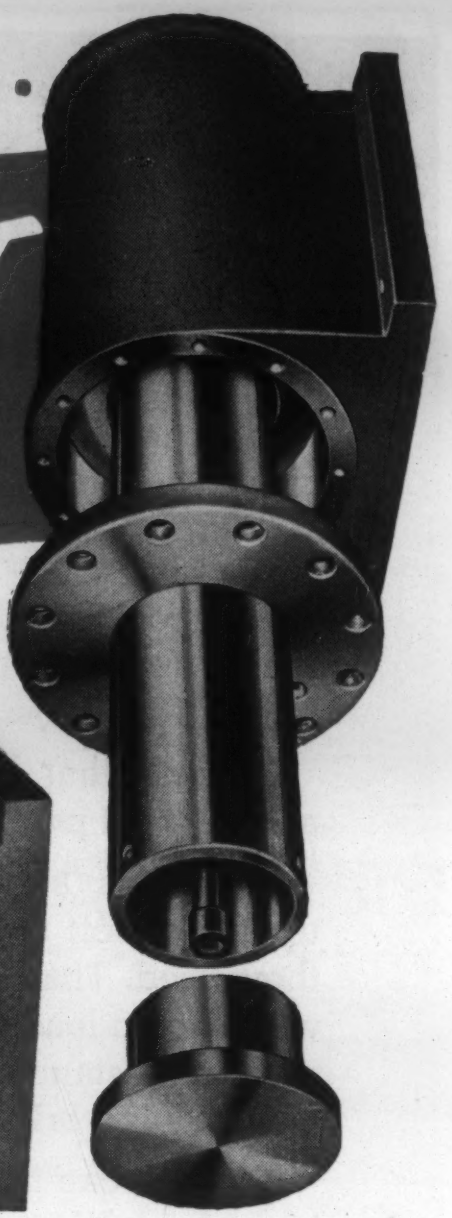
This MEEHANITE Ram Cylinder is...

"GUARANTEED AGAINST FAILURE"



Left—Ross & Company 20 Ton Hydraulic Press for Shop—Tool Room or Production Line





Right—The double acting Meehanite Ram Cylinder, honed to a mirror finish, is the heart of the hydraulic pump system.

Ross & Company, Chicago, Illinois, manufacturers of the 20-ton hydraulic press illustrated, fully guarantee their product "against failure due to workmanship or *material* for six months after date of sale." As an important component of this unit they specify only Meehanite cylinders which must be honed to a mirror finish. The versatility and accuracy of the action of the hydraulic pump is largely dependent upon the cylinder and its flawless, long wearing surface.

Only through rigid control of the metal structure can the needed engineering characteristics for a part of this type be obtained regularly and consistently. The Meehanite production processes provide these controls with the result that to designers, engineers and production executives throughout industry, Meehanite castings are synonymous with better properties, uniformity, dependability:—in a simple word QUALITY.

Write for our 25th Anniversary booklet "25 Years of Proof in Service."

25th Anniversary — METAL — 1926-1951

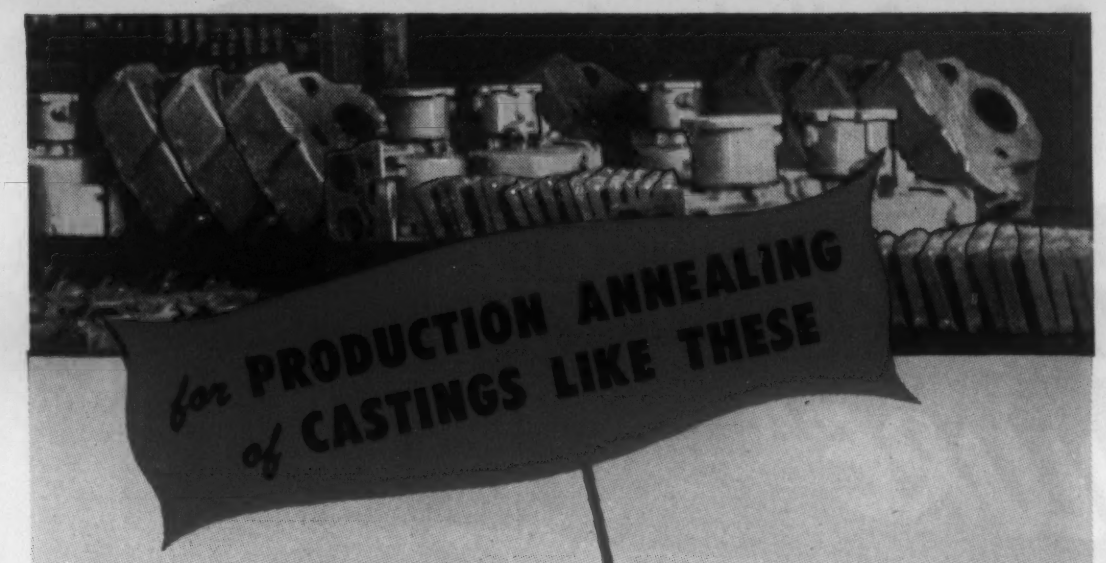
MEEHANITE®

NEW ROCHELLE, N. Y.

Take *YOUR* Casting Problem To A MEEHANITE FOUNDRY

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
E. W. Bliss Co.	Hastings, Mich. & Canton, O.
Builders Iron Foundry	Providence, Rhode Island
Compton Foundry	Compton, California
Continental Gin Co.	Birmingham, Alabama
Crawford & Doherty Foundry Co.	Portland, Oregon
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio & Grove City, Pa.
Empire Pattern & Foundry Co.	Tulsa, Oklahoma
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Hardinge Company, Inc.	New York, New York
Hardinge Manufacturing Co.	York, Pennsylvania
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Lincoln Foundry Corp.	Los Angeles, California
E. Long Ltd.	Orillia, Ontario
Otis Elevator Co, Ltd.	Hamilton, Ontario
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Standard Foundry Co.	Worcester, Massachusetts
Sonith Industries, Inc.	Indianapolis, Ind.
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
Valley Iron Works, Inc.	St. Paul, Minnesota
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

"This advertisement sponsored by foundries listed above."



This compact Holcroft furnace anneals, descales and desands castings at a production rate of 10,000 lbs. per hour.

Not only that, but it delivers the castings at a lower cost per piece.

Foundries all over the country depend upon Holcroft to give them the furnace help they need. That's because Holcroft is such a well-known leader in the field. Many foundry practices, standard procedure today, were basic ideas worked out by Holcroft engineers.

You, too, can take advantage of this furnace know-how. Write today for complete information. **Holcroft and Company, 6545 Epworth Blvd., Detroit 10, Michigan.**

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PRODUCTION HEAT TREAT FURNACES FOR EVERY PURPOSE

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Windsor, Ontario

EUROPE
S. O. F. I. M.
Paris 8, France

New Materials and Equipment

is expected to find its most significant use as a structural material in the manufacture of high-speed aircraft and guided missiles.

The new resin has physical and handling properties comparable to other types of polyesters now available, with the added benefit of high strength at high temperatures. Laminates made with the resin and glass fabric retain good flexural strength (40,000 to 47,000 psi) when exposed for as long as 200 hr at a temperature of 300 F. Good flexural strength (over 30,000 psi) is also said to be obtained when exposed for as long as 24 hr at 500 F. The heat resisting properties of the resin are made possible by the use of a new chemical, triallyl cyanurate.

Initially, the new product will be available for military applications. However, the company is boosting production capacity in order to supply resin fabricators who require heat resistance for applications in the electrical, electronic, radio and television industries.

Self-Lock Pin Eliminates Precision Reaming and Peening Operations

Self Lock Fastener Corp., 259 Stephens St., Belleville 9, N. J., has announced a heat treated tubular slotted dowel pin manufactured in both standard and light duty types.

An inexpensive, high efficient hollow fastener with chamfered ends permitting easy, rapid insertion, the pin becomes compressed as it is driven or pressed in place. When the pin is placed in the hole it remains tight and secure against vibration, but can be removed with a drift punch if required.

Due to the spring quality of the fastener, it can be re-used. Its ability to resume the original diameter is inherent. As it is self-locking, normal production hole tolerance is all that is required, eliminating precision reaming and costly peening operations.

New Fastener Provides Positive Locking

The Security Locknut Corp., Melrose Park, Ill., has announced a capnut to be known as the Security Caploc. This de-

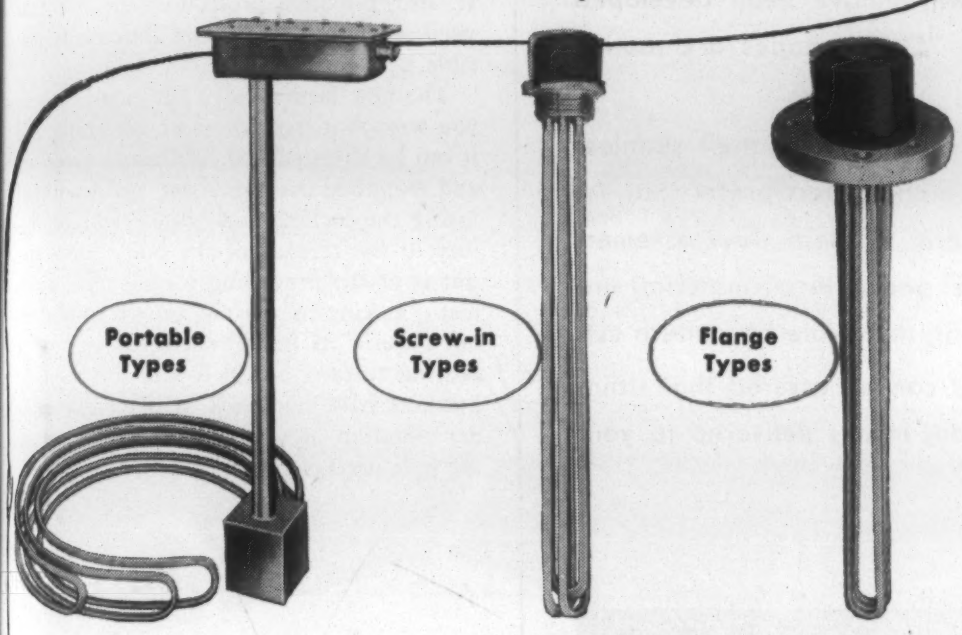
CHROMALOX

Electric Immersion Heaters

for Heating Water, Oils

Waxes, Heat-Transfer Mediums

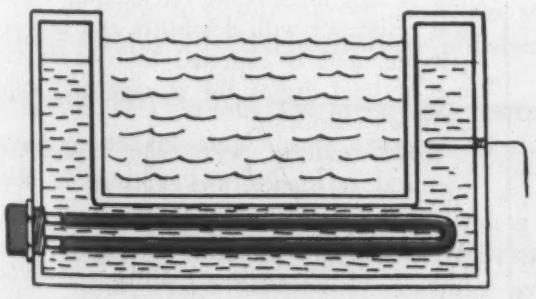
and other Liquids



Look to CHROMALOX for Dependable Electric Heat

CHROMALOX Electric Immersion Heaters come in a full range of types for permanent or portable use. They are quickly and easily installed with minimum labor and material costs . . . and they may be manually or thermostatically controlled for accurate, care-free, dependable operation. Available in types and sizes to fit your needs in iron, steel or alloy sheaths to resist corrosion.

If you are interested in heating liquids efficiently, or if you have any other heating problem—you are invited to consult CHROMALOX.



A Typical application

Indirect immersion heating with Chromalox Electric Tubular Heaters.

OTHER UNITS AVAILABLE FOR HEATING:

Water, asphalt, greases, molten salts, pickling baths, Dowtherm, Aroclor, Prestone—for superheating steam and compressed air—for melting lead, solder, babbit and stereotype metal.

CHROMALOX

Electric Heat for Modern Industry

CHROMALOX

offers you the most

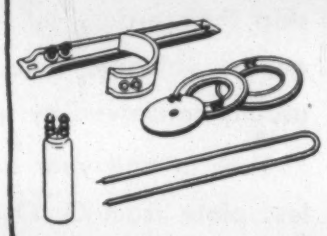
in

Electric Heat

Experience

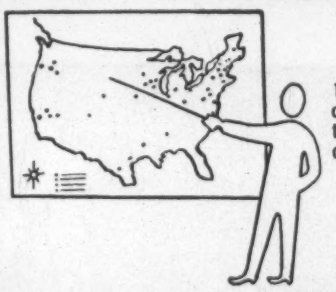
33 years experience in electric heating, covering almost every industrial process employing heat up to 1000F°

Selection



Over 15,000 types, sizes and ratings to fit most every application requiring heat.

Service



135 field engineers in 87 cities throughout the country, to give you on-the-job counsel and assistance.

Engineering

Application engineers working with research, development and manufacturing personnel provide technical know-how for solving industrial heating problems.

FOR COMPLETE INFORMATION Write for Catalog 50 which describes the complete Chromalox facilities and products designed to meet your heating requirements.

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Please send me a copy of the new 48 page Chromalox Catalog.

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an

ODD SHAPE *in*

stainless plate?

Not at G. O. Carslon, Inc., for our complete service in stainless plate items is backed up by special cutting equipment and techniques which have been developed and refined over the years. "Odd" shapes are routine at G. O. Carlson, Inc.

While many of our customers purchase their stainless plate in sheared rectangles, many others prefer that we ship their orders cut to pattern. In these days of emergency, valuable time, labor and critical material are usually conserved by specifying that plate be pattern cut.

Year in and year out, you can be assured that stainless plate from G. O. Carlson, Inc. is delivered to your specifications.

Stainless steel is our only business . . . and we know it.

G. O. **CARLSON, INC.**

Stainless Steels Exclusively

200 Marshalton Road, Thorndale, Pa.

PLATES • FORGINGS • BILLETS • BARS • SHEETS (No. 1 Finish)

District Sales Offices and Warehouse Distributors in Principal Cities

New Materials and Equipment

vice provides a positive locking of the Security locknut wherever acorn or capnuts must be used, and according to the company, it affords protection against moisture and corrosive action that destroy bolt ends and make a nut non-removable. It also provides protection for the bolt itself where mutilation and abrasion is possible.

The new fastner stays put exactly where you wrench it, regardless of vibration, and it can be adjusted and readjusted, removed and reapplied over and over again without losing the locking power and without injury to the threads of the bolt. Since the nut is of the prevailing torque type, automatic locking of the nut on the bolt does not require its being wrenched against a bearing surface, and it is said the Security locknuts have remained in place even under vibration stress great enough to destroy the bolt itself.

Container Coating Uses New Resin

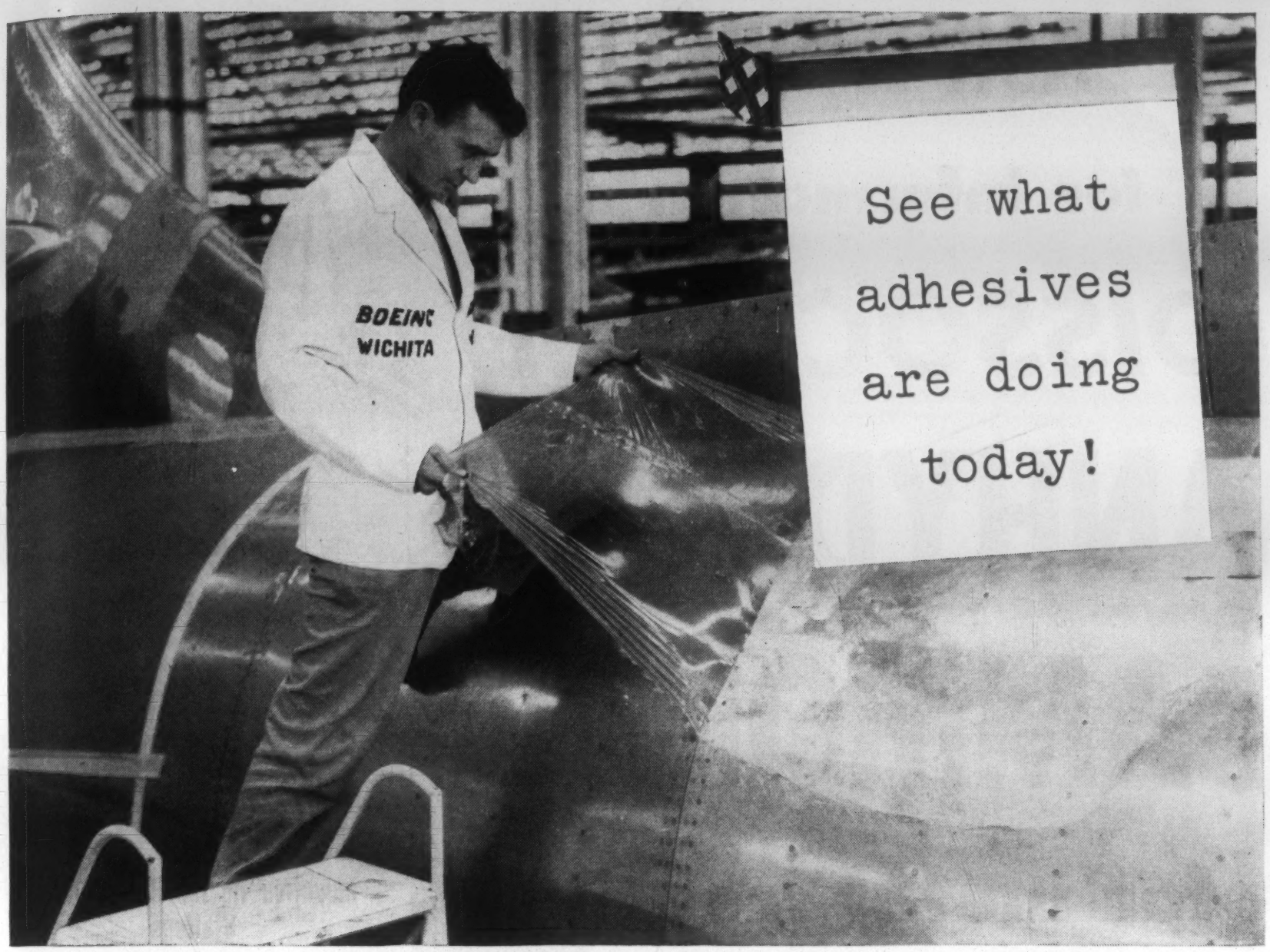
New chemical processing applications for baked coatings based on G-E's new coating intermediate R-108 have recently been announced by *General Electric Chemical Div.*, Pittsfield, Mass.

Synthetasine 100, a new protective coating for steel shipping drums and pails currently being offered by *Synthetasine Protective Coatings, Inc.*, is formulated with the new coating intermediate. This coating is said to combine outstanding chemical resistance with flexibility and heat resistance, and is expected to broaden the use of steel drums for storage and shipment of chemicals.

R-108 coatings, with their exceptional chemical resistance, are expected to help alleviate the increasing shortages of alloy metals in chemical processing equipment. Lithcote LC-33, another coating formulated with the new intermediate, has been developed by *Lithcote Corp.*, Chicago.

New Finish to Expand Use of Polystyrene

Development of a new plastic finish for polystyrene, C 5138, which is expected to expand the use of polystyrene in a wide variety of products, has been announced

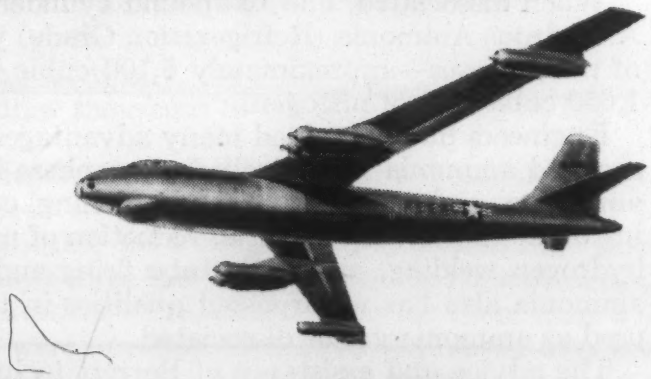


"Saving face" for American metal

Did you know that the speed of an airplane can be cut as much as 20 miles per hour by mars and scratches on the metal skin?

Like other aircraft manufacturers, the Boeing Airplane Company was faced with the problem of metal protection. Working with Boeing engineers, 3M developed a *strippable coating* which could be sprayed to sheet stock before it started down the production line. This tough, elastic coating effectively protects polished surfaces during handling and forming operations . . . right down to final inspection. Easily removed, this famous 3M strippable coating has saved Boeing—and other manufacturers—large amounts of time and money by "saving face" of polished metal.

Wherever highly polished metal is used, a 3M strippable coating can save money by reducing rejects, saving repolishing costs and speeding production. These strippable coatings are another example of an *engineered* adhesives application from 3M, one of the country's largest producers of industrial adhesives, coatings and sealers.



See what adhesives can do for you . . .

It will pay you to investigate the metal-saving possibilities of strippable coatings. Call your 3M salesman and let him give you the complete story. And for information on all Adhesives, Coatings and Sealers, write 3M, Dept. 62, 411 Piquette Avenue, Detroit 2.

3M COMPANY

OVER 1,000

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for metal treating

You effect real economies in metal treating when you use Barrett* Standard Anhydrous Ammonia as a replacement for other more expensive sources of hydrogen and nitrogen.

When dissociated, one 150-pound cylinder of Barrett Standard Anhydrous Ammonia (Refrigeration Grade) yields 6,750 cubic feet of mixed gases—approximately 5,100 cubic feet of hydrogen and 1,650 cubic feet of nitrogen.

Engineers have obtained many advantages from the use of dissociated ammonia as controlled atmosphere in furnaces for bright annealing, carbonitriding, clean hardening, copper brazing, sintering of metal powder compacts, reduction of metallic oxides, atomic hydrogen welding, and radio tube firing and sealing. Anhydrous ammonia also has unsurpassed qualities in the nitriding of steel, used as ammonia gas or dissociated.

The advice and assistance of Barrett technical men are readily available. For information, contact Barrett, *America's leading distributor of ammonia.*

Barrett Standard Anhydrous Ammonia

In 150, 100 and 50-pound cylinders for fast delivery from a stock point located near you. And in tank car shipments from Hopewell, Va., and South Point, Ohio.

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New Materials and Equipment

by *United Lacquer Manufacturing Corp.*, 1001 W. Elizabeth Ave., Linden, N. J.

When applied to polystyrene by dipping or by spraying with standard equipment, C 5138 is said to flow easily and result in a finish with luster and smoothness.

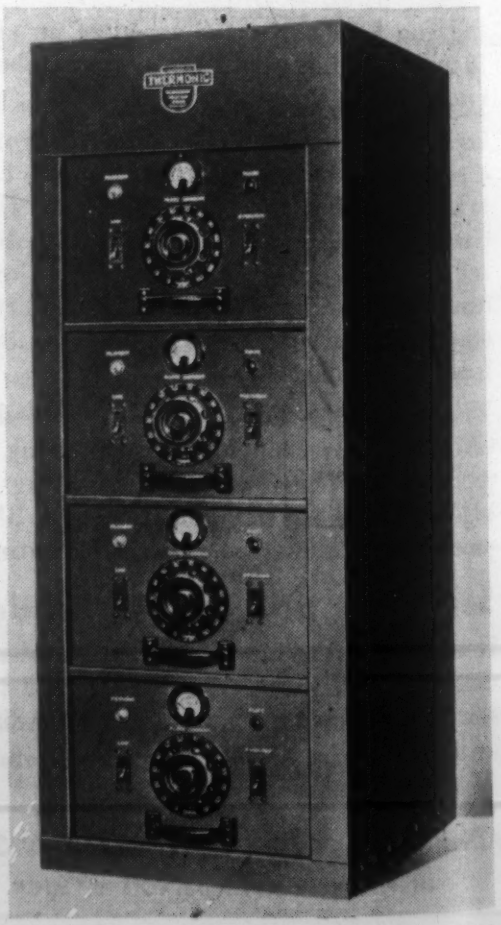
If desired, it can be machined easily, with accurate control. This property is expected to prove exceedingly valuable in replacing glass in the manufacture of toys, novelties and kitchen and office supplies.

The new finish, according to the company, has excellent durability, adhesion to the polystyrene and resistance to perspiration. It does not attack polystyrene and cause minute cracks and wrinkles. It is available in all standard colors, in gloss, semi-gloss and flats.

Induction Heater Has Multiple Stations

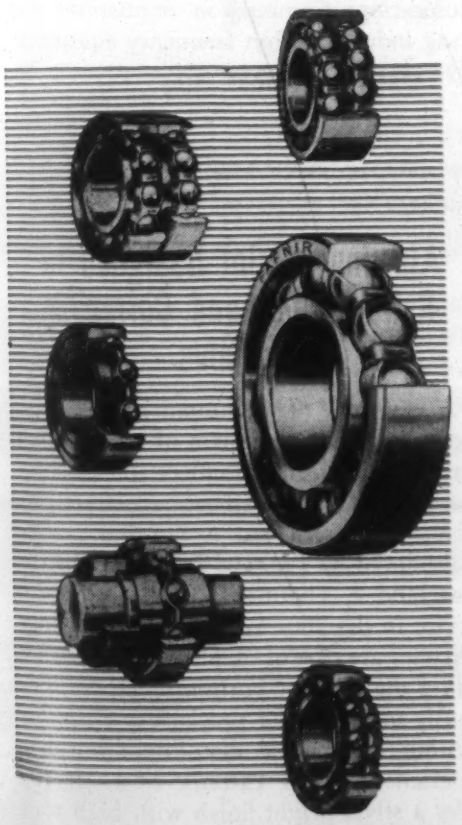
Multiple 2½-kw units, combined in a single cabinet, are now available for general purpose induction heating applications from *Induction Heating Corp.*, 181 Wythe Ave., Brooklyn 11, N. Y.

This new type of induction heating



This induction heater is especially suited for high production industries.

HERE'S HOW...



FAFNIR USES 20 LINDBERG CYCLONES

...to draw thousands of types of bearings!

The Fafnir Bearing Company, New Britain, Conn., uses Lindberg Cyclone Furnaces to draw thousands of types and sizes of its line of ball bearings. They say:

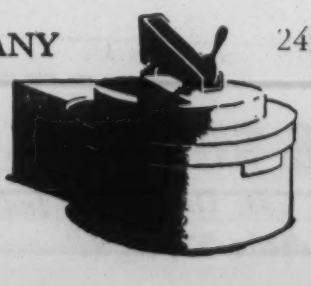
"The metallurgical department of our company entrusts the major part of its drawing operations to Lindberg Cyclone Furnaces because it has found them to be dependable work horses. At the present time there are 20 in use in the Company's three ball bearing plants in New Britain, Conn.

"They have given excellent continuous service for more than 8 years. For long periods they were operated 24 hours a day, seven days a week, (at temperatures ranging from 275 to 1200°F.) without downtime due to furnace failure.

"Because the Fafnir line of ball bearings,comprising thousands of types and sizes, is considered the most complete manufactured in this country, the Lindberg Cyclones draw a considerable variety of parts. The work varies from small to large dense loads (up to 1600 lbs.) of bearing rings, balls and rolls, yet the uniform results demanded for the manufacture of precision products is constantly being achieved—and in an atmosphere of cleanliness and satisfactory working conditions."

Local Offices in every industrial center.

LINDBERG ENGINEERING COMPANY 2451 W. Hubbard Street, Chicago 12, Illinois.

LINDBERG  FURNACES

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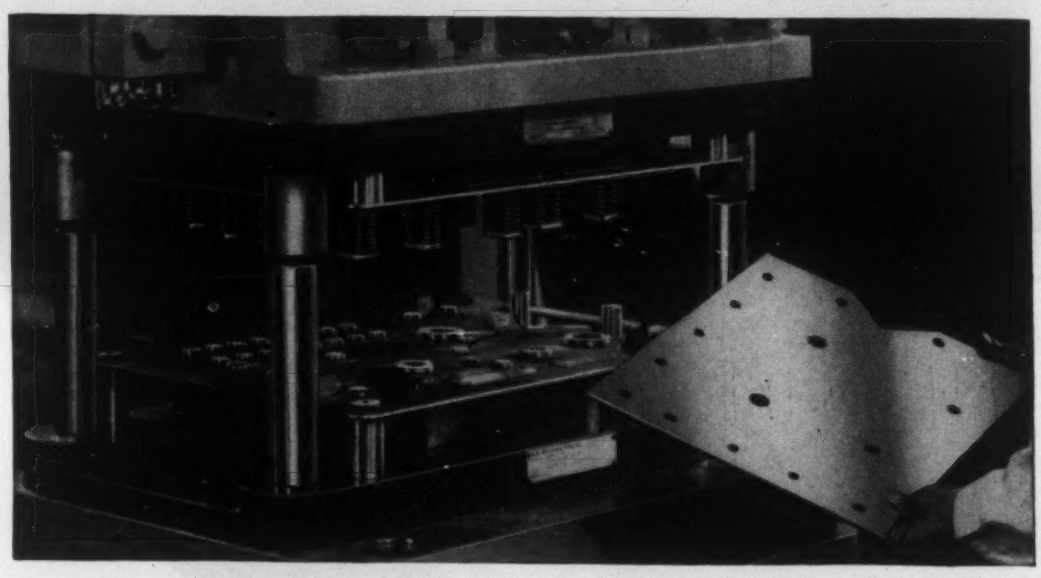
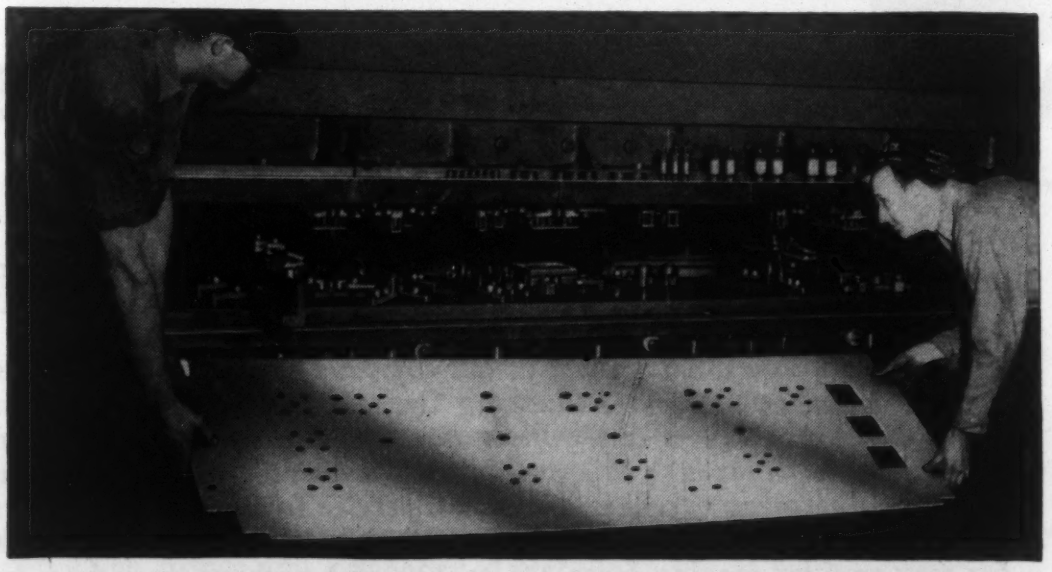
LOW COST methods for PERFORATING and NOTCHING SHEET METALS

Both methods feature: LOW DIE COSTS

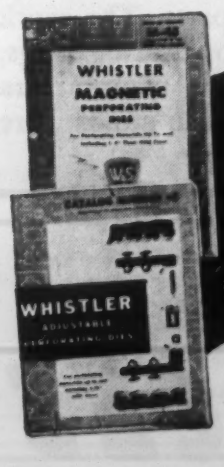
All units and parts are interchangeable and used repeatedly in different arrangements. **INCREASE PRESS PRODUCTION** – Down time is minutes as compared to hours for changeover. For precision work in all types and sizes of presses. **START PRODUCTION *at once.*** Pierce up to ¼" thick mild steel. Saving money in the best known plants.



Whistler *MAGNETIC* Dies at work in large inclinable press. Magnetized units hold the retainers. No bolting required. A fast, economical method in making up a punch and die set for short or long runs. All parts re-usable.



Whistler *ADJUSTABLE* Dies on ⅛" steel perforating and notching job, using Tee slotted die set. With Whistler Adjustable Punch and Die units production starts within hours instead of weeks. Last minute job changes made quickly.



Here are the complete details with prices and application illustrations. Send for these catalogs. No obligation.

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Adjustable, Magnetic, Custom and Cam Dies for all Industry

756 Military Road, Buffalo 23, N. Y.

New Materials and Equipment

equipment is said to fill the need especially for high production industries. Individual units can be removed and replaced, similar to a drawer of a filing cabinet. The heating stations can be located at any place in the production line. The unit also fills the need between the existing low power and medium high power machines that industry has long awaited, for it is no longer necessary to use and tie up a high power oversize generator to do a medium size job.

Equipment includes circuit breaker type switches for primary and heat on circuits; load indicating ammeter, optional; continuously variable output control for zero to full power applications; automatic heat-on timer; filament and heat-on indicators; quick disconnect plugs and receptacles for connecting power section to heating section. This last feature enables a heating section to be quickly interchanged from one power unit to another in the event of a power section breakdown, or from one heater to another.

Input requirements per section are 4 kva at 220 v, 60 cycles, single phase, and the unit is built to conform to Federal Communications Commission regulations covering industrial high frequency equipment.

Aluminum Paint Designed to Relieve Rust and Corrosion Problems

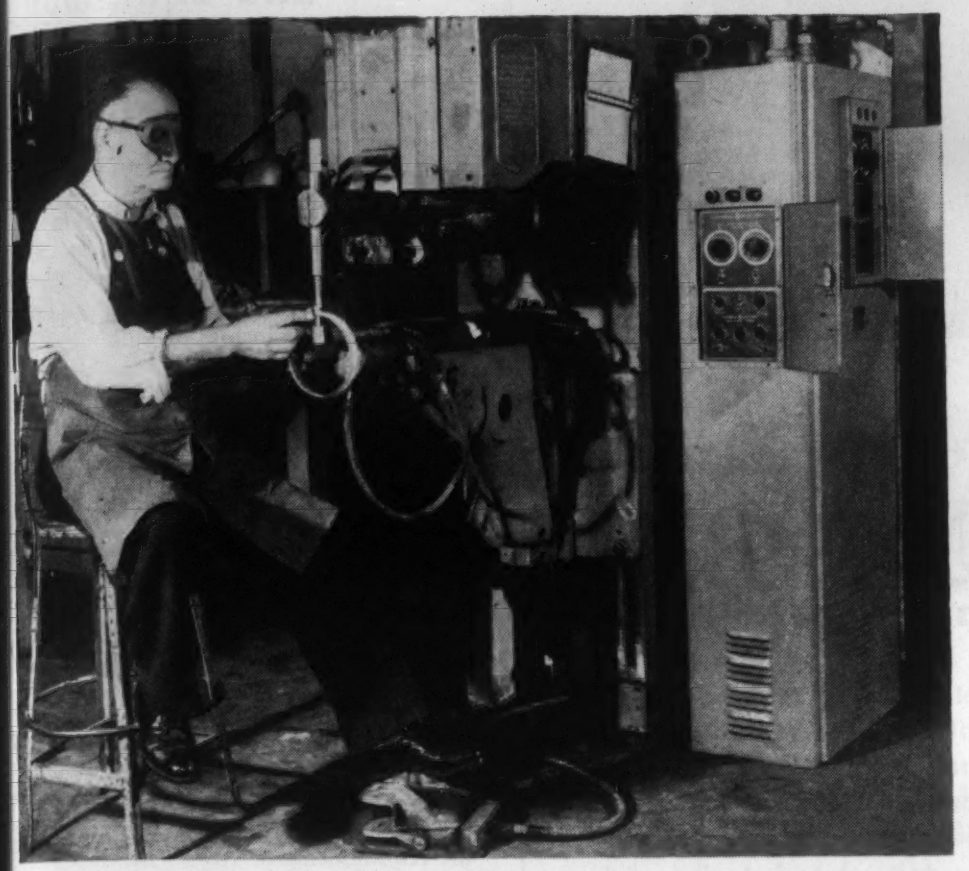
A new type of aluminum paint may go far to relieve the problem of rust and corrosion of manifolds, mufflers and exhausts, caused by extreme heat, moisture and acids.

Produced by *Tropical Paint and Oil Co.*, Cleveland 2, Thermalite was developed to service in the 200- to 1000-deg heat range. Silicones are part of its film-forming solids, aiding the metallic portion to adhere tenaciously to metal and preventing blistering, burning, flaking or discoloration usually experienced under extreme heat. It provides a silver-bright finish with high resistance to rust, heat, chemical fumes and weather.

The new paint requires a temperature of 200 F for an hour to fuse or set it on the metal. Already used successfully to prevent deterioration and provide good appearance on airplane and Diesel exhaust stacks, it is also finding wide use on mufflers, manifolds and engine blocks, especially where constantly exposed to the weather.

According to the company, the high heat

Solar Aircraft Welds Close to the Edge

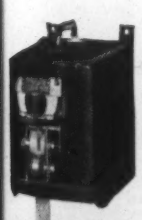


Material does not split out, spattering is reduced on this jet engine part because G-E slope control permits a gradual increase in welding current that also reduces tip pick-up and spatter. More welds can be made before electrodes must be cleaned. Welds are sound and uniform. Bulletin GEC-534.

G-E Slope Control for Resistance Welding Prevents Split-outs on Stainless Steel Jet Engine Parts

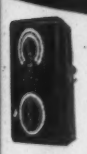
More precise work possible with this resistance welding accessory used with G-E synchronous control.

Be sure of consistent, high-quality welds with these G-E Accessories

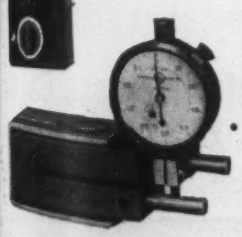


DETERMINE THE BEST TIMING FOR A JOB Portable, inkless G-E cycle recorder makes a record of the exact timing on test welds, is then used as a check to verify the setting on machines in production. Bulletin GEC-376.

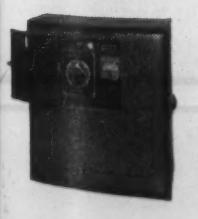
HOLD WELDING CURRENT CONSTANT Regardless of line-voltage variations of as much as plus 10 per cent and minus 20 per cent, the G-E electronic voltage-regulating compensator holds welding current constant. Bulletin GEA-4223.



REDUCE BRITTLENESS Heat treat medium-carbon, low-alloy, or high-alloy steel with G-E tempering control. Easily installed and operated. Adjustable to suit thickness and type of metal welded. Bulletin GEA-4201.



MEASURE ELECTRODE FORCE Check existing gages on spot, seam, or projection welders or at time of set up. Easy to use, saves time, acts as a production check. Force range: 0 to 4500 pounds. Small, portable. Bulletin GEA-3628B.



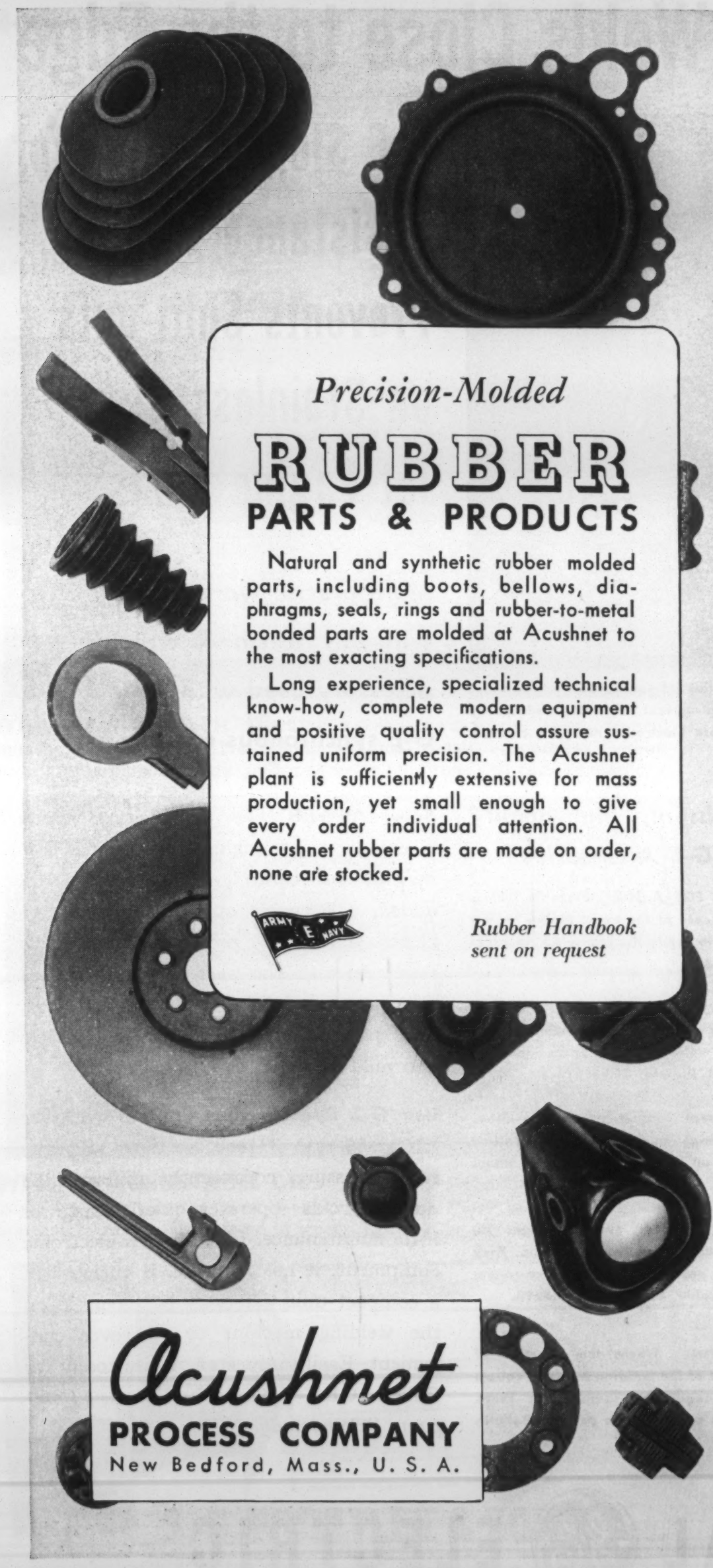
PREVENT CURRENT VARIATIONS Where the insertion of magnetic material in the throat of the welding machine causes weld variations, the current-regulating compensator keeps current constant to within plus or minus two percent. Bulletin GEA-4207.

Solar Aircraft, like many other plants working on jet engines, has found G-E synchronous control, with slope control added, will enable operators to work to closer tolerances, produce faster, with fewer rejects. The part shown is welded close to the edge but does not split out, and spatter is reduced on both stainless and mild steel.

Use G-E Synchronous Control wherever AN-W-30 and 32 specifications must be met. It assures consistently uniform high quality welds—operates quietly, requires little maintenance. Like all G-E electronic equipment, it has long life, is enclosed in a compact unit that may be mounted on the welding machine or wherever convenient. Easily inspected. Write today for Bulletin GEA-4699. *General Electric Company, Schenectady, N. Y.*

GENERAL ELECTRIC

645-54



Address all communications to 750 Belleville Ave., New Bedford, Mass.

New Materials and Equipment

resistance of the product made it quickly popular for varied applications, including boiler fronts, melting pots and ladles, steam lines, hot exhaust tunnels and stacks of all types, the insides of vulcanizers and baking ovens, and similar problem surfaces.

Synthetic Rubber for Use in "O" Ring Seals

A new formulation of synthetic rubber "O" Ring Molding Compound 90, which is said to supply properties which exceed the requirements of Army Ordnance Specification AXS 1440, Class "A", has been announced by *Parker Appliance Co.*, 17325 Euclid Ave., Cleveland 12.

This elastomer is being used in "O" ring seals for tanks and other military vehicles, and is marked by superior heat resistance (to 225 F), low compression set and high hardness—particularly useful in difficult high pressure applications involving oil resistance.

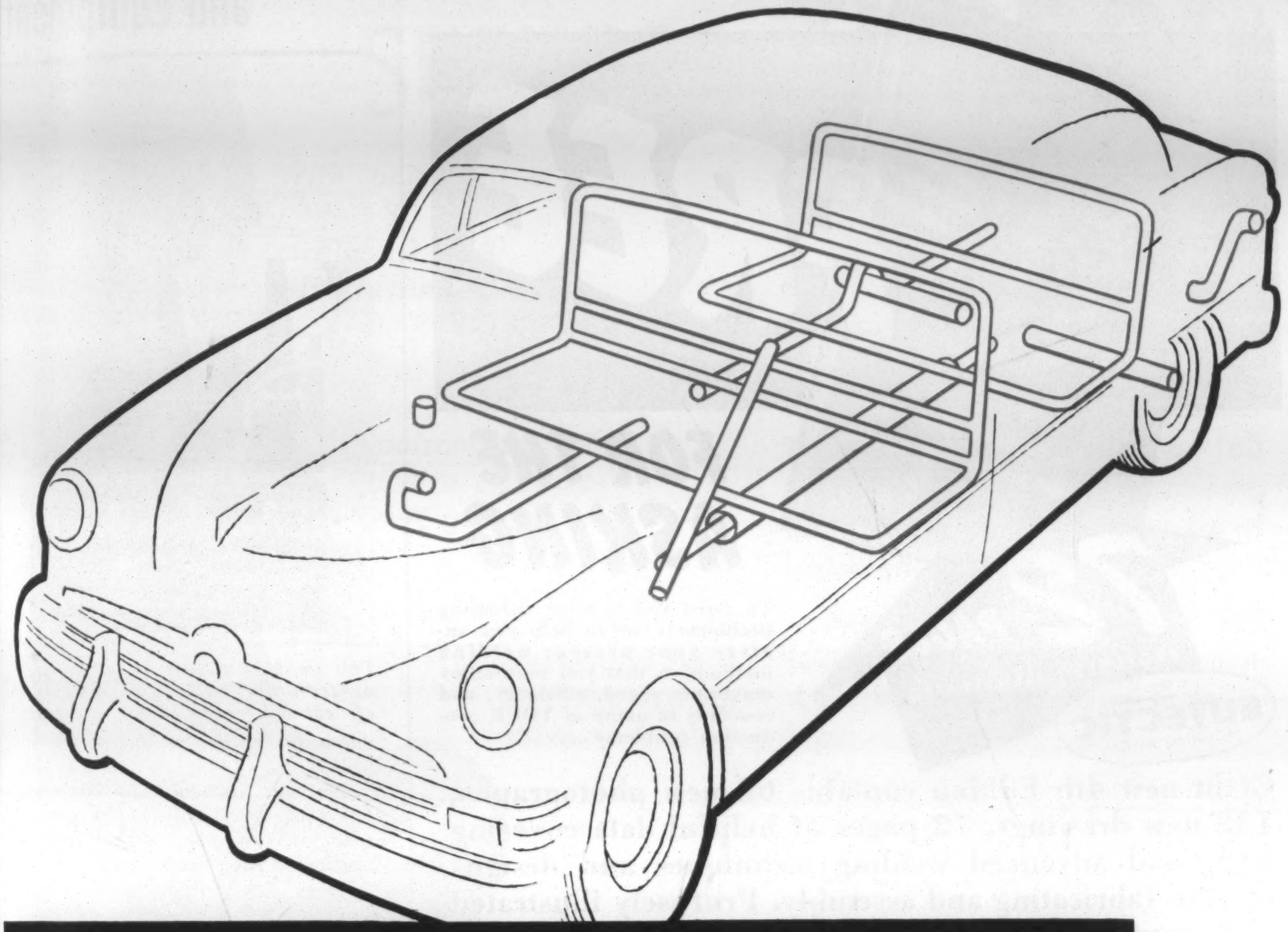
Parker Compound 90 is said to have a tensile strength of 1450 psi with no loss of strength after seven days' aging either in air or AXS 808 oil at 158 F. Elongation is 210, with a 150 value after aging. Hardness is Shore 90, unaffected by aging, and volume swell in the seven-day hot oil test is only 4.6%.

Improved Tin Plate Thickness Gage Utilizes an X-Ray Beam

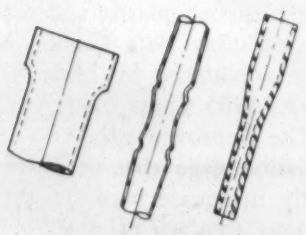
An improved tin-plate thickness gage, which provides a non-destructive method for checking the efficient and economical use of this metal, is currently in production at the Research & Control Instruments Div., *North American Philips Co., Inc.*, 750 S. Fulton Ave., Mt. Vernon, N. Y.

The design utilizes an x-ray beam which is directed upon the surface of the sheet under test. Through proper kilovoltage control of the beam, the tin plating is penetrated, the beam striking the underlying steel. Rays emitted by the iron are measured by means of Geiger counters, and the intensity can be expressed as a logarithmic function of tin plate thickness. In practice

another job for Brainard ELECTRIC-WELDED TUBING



MASS PRODUCTION PARTS FOR THE HIGHWAY



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Brainard tubing is a uniform product made to close tolerances. Has good machining qualities and finish can be supplied as specified. Easily fabricated—can be beaded, expanded, swaged, spun, flanged, upset, grooved, fluted, flattened, tapered, and otherwise formed. Supplied straight or fabricated, sizes ½″ to 4″ O.D.; .025 to .180 gage.

Expanded production at Brainard's new tube mill permits fast delivery on certain sizes of electric-welded steel tubing. Send coupon for immediate information.

●Go no further than your own car to find the wide application of Brainard Electric-welded steel tubing.

The automotive industry fabricates Brainard tubing in a hundred shapes. For hard-working parts—propeller shafts, torque tubes, steering columns. For structural members—tubular seat frames, rear axle housings. For air, gasoline, and exhaust lines.

Brainard's integrated production facilities assure quality control throughout manufacture . . . from ore to finished tubing. You can depend on Brainard service for *your* needs. District offices in principal cities throughout the U. S.

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This new manual of yours sounds like a very helpful book. Send me a FREE copy with the understanding that there will be no cost or obligation now or later.

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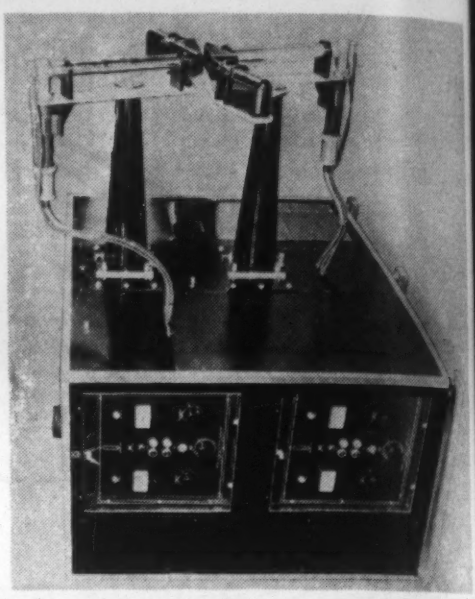
New Materials and Equipment



This tin plate thickness gage provides a nondestructive method for checking the efficient and economical use of the metal.

this is reduced to a reading on a printing register.

The gage has four main components: (1) x-ray optical system; (2) x-ray generator; (3) detecting circuits; and (4) registration equipment.

Beta Ray Gage for Use with Rubber, Plastics and Paper

Designed specifically for continuous measurement of sheet material produced in the rubber, plastic and paper industries, the AccuRay Beta Gauge, Model R, has been announced by *Industrial Nucleonics Corp.*, 1205 Chesapeake Ave., Columbus.

The improved gage is a non-contacting radiation gage that provides readings directly in square yard weight with a continuous accuracy of ±1%.

New features of the unit include an automatic control for positioning the measuring unit across the sheet to provide profile readings and a control for the selection of desired weight ranges. Another Model R development is the remote control station with repeat meter which permits the calender operator to read and control the gage from a distant point.

Of further aid to the operator is the AccuRay recorder, which can be equipped with target and tolerance marking pens to provide him with a comprehensive working picture at a glance. Also available are chart marking pens for recording the weight range and the sheet position of the AccuRay. This provides management with a permanent record for each roll of processed material.

The measuring unit is produced in size

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MIDGET

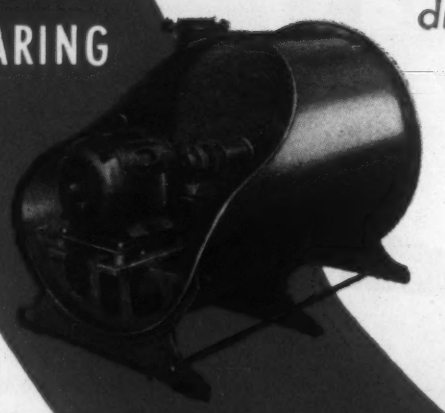
With universal motor, 35 to 75 cfm at 12 to 40 oz. pressure

GAS BOOSTER

For handling gas, acid fumes, poisonous, corrosive or explosive gases

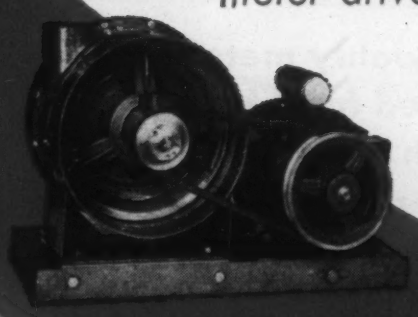
Overhang or outboard type for coupled drive

4 BEARING

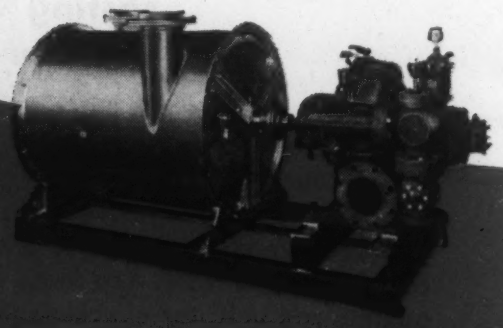


For odd frequency or other than electric motor driven

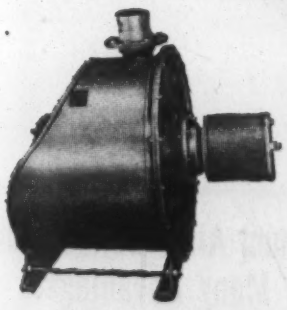
BELT DRIVE



For use where it is desired to operate with steam



TURBINE DRIVEN



AIR FILTERS

Of various types for intake of Turbo

Standard motor driven Spencer Turbos are listed in more than 160 sizes. For special applications, there are many variations, six of which are illustrated.

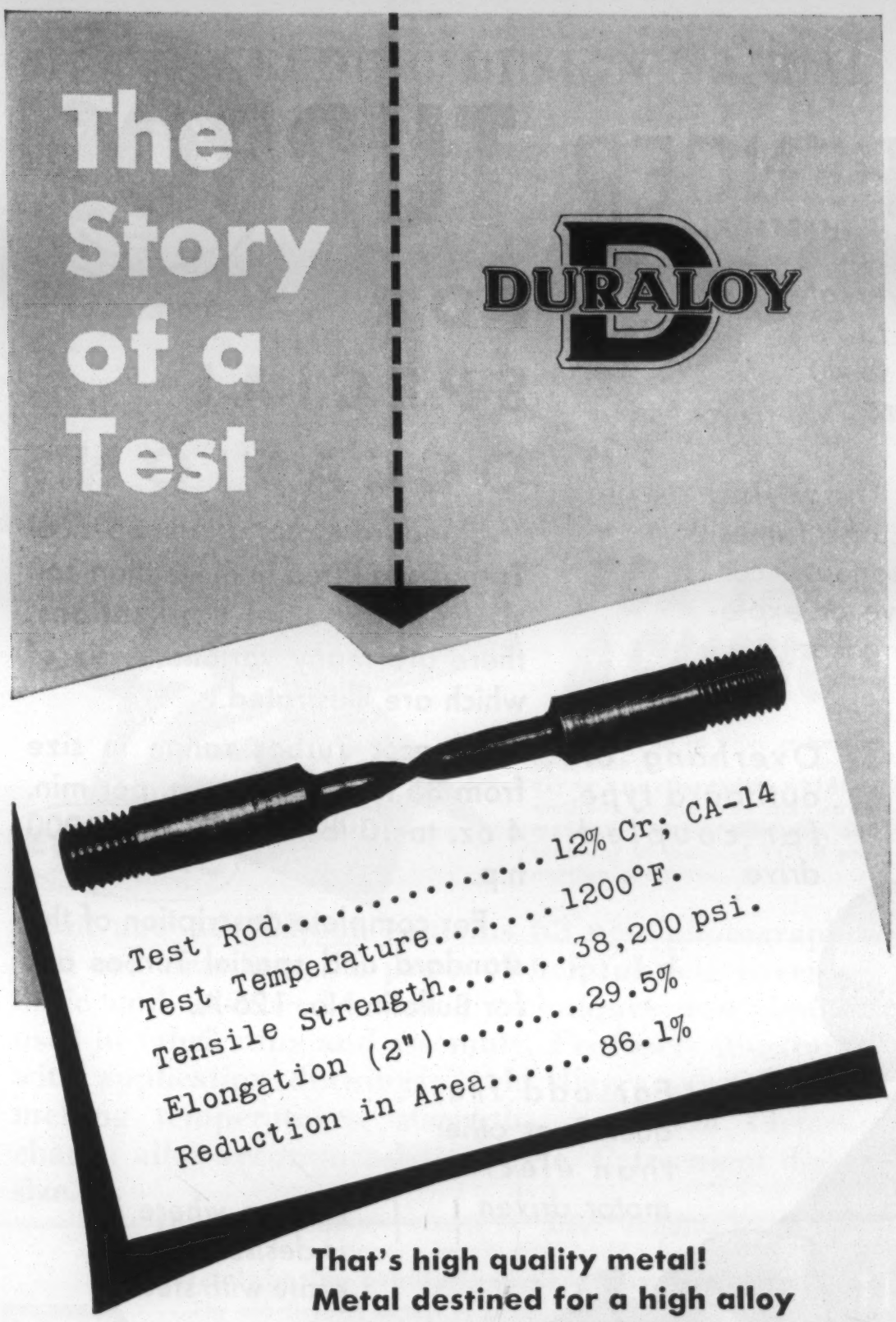
Spencer Turbos range in size from 35 to 20,000 cu. ft. per min. 4 oz. to 10 lbs. and 1/3 to 1,000 h.p.

For complete description of the standard and special Turbos ask for Bulletin No. 126-A.

440-F

THE SPENCER TURBINE COMPANY • HARTFORD 6, CONNECTICUT

SPENCER HARTFORD



That's high quality metal! Metal destined for a high alloy casting which has to meet some pretty rigid specifications!

The story we want to tell here is about our Testing Facilities. We have right in our foundry every conceivable testing facility needed when checking static or centrifugal high alloy castings for industry. Where required, we make complete chemical, metallurgical, and mechanical checks and tests. And have both a 400,000 volt X-ray unit and gamma-ray unit, for checking the final casting for hidden flaws.

As we see it, the only way to assure customers of high quality castings is to have and use all necessary facilities for testing and checking the heat, pour and finished casting.

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New Materials and Equipment

to permit measurements up to 24, 36, 48 and 60 in. from the edge of the sheet.

Basically, the gage consists of a beta radiation source below the sheet to be measured and above it a detector to measure the amount of radiation that penetrates the sheet, plus a recorder to present this information in terms of weight per unit area.

According to the company, the unit is responsible for large savings in materials, total elimination of sampling costs, and greatly improved quality control.

Improved Polystyrene Lacquer Features High Gloss and Strong Adhesion

The New England Lacquer Co., King Philip Rd., East Providence, R. I., has produced an improved polystyrene lacquer. It features a high gloss, strong adhesion and bright, long lasting colors—a combination of qualities which has been hard to find in polystyrene lacquers.

Easy to apply, this new lacquer is suitable for spraying, wiping, flocking and silk screen methods. It is available in clear or in a complete range of colors, and can be obtained in various degrees of gloss. Other features include blush-resistance, excellent coverage and quick-drying qualities.

New Aluminum Alloy Coiled Tubing Offers Many Advantages

Aluminum Co. of America, 801 Gulf Bldg., Pittsburgh 19, has announced a new general purpose aluminum coiled tube made of new Alcoa aluminum alloy B50S-0, which is suitable for a variety of industrial uses.

The new alloy tubing is said to combine low cost per foot, easy workability, and high fatigue strength among numerous other advantages.

According to the company, Utiltube can be used in fuel oil, gasoline and lubricating oil lines for internal combustion engines; in fuel gas lines for stoves and heaters; also in air, vacuum and hydraulic lines for brakes and instruments. The new product with similar ease will handle kerosene, cutting compounds for screw

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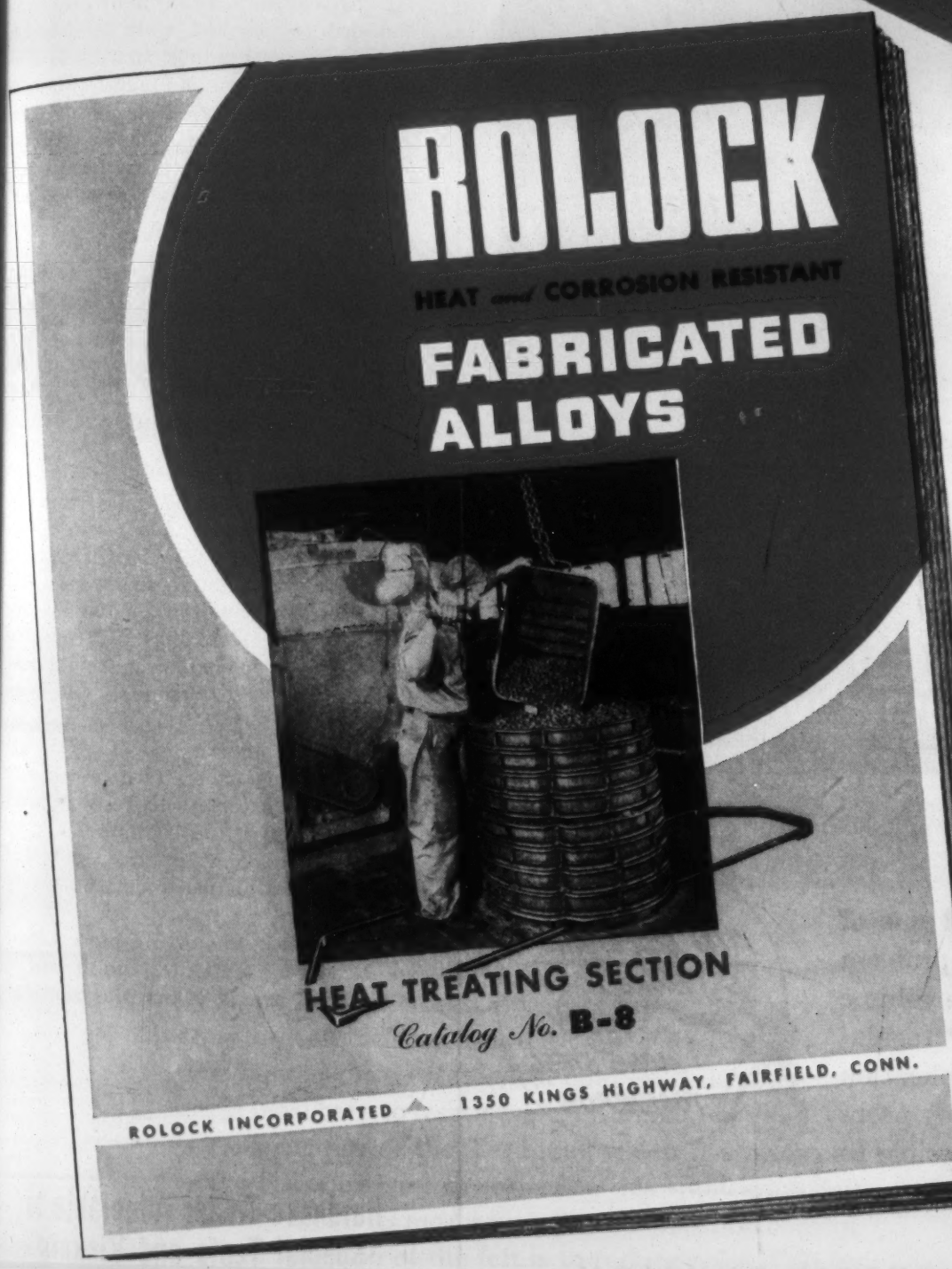

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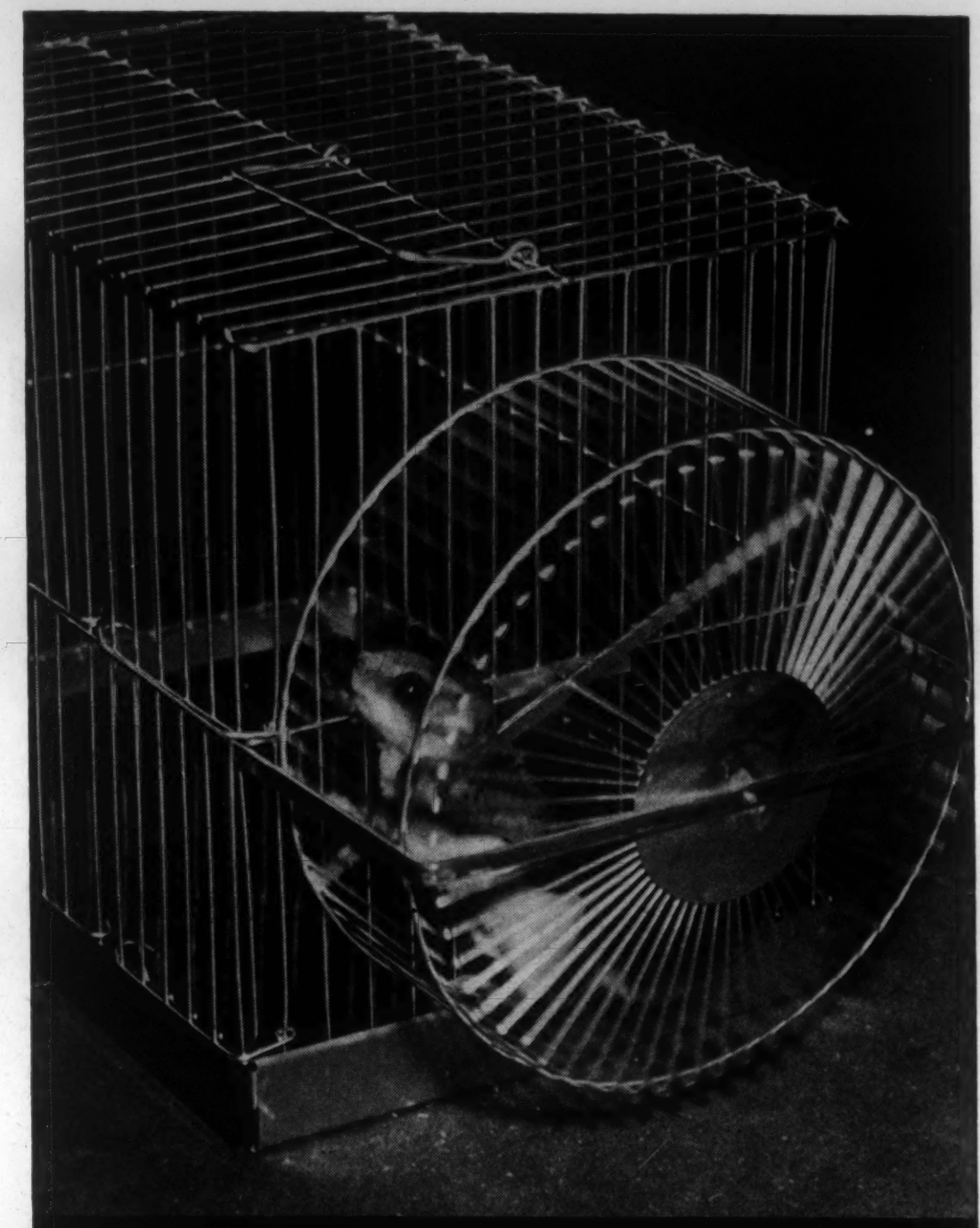

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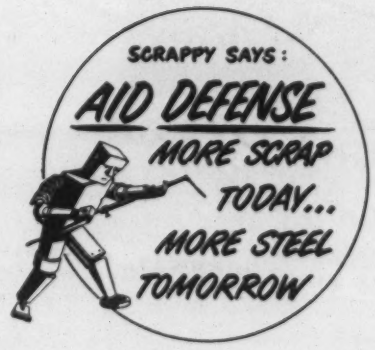
Let us try to help you! Call one of our salesmen when you have a problem on CMP. He has handled a large volume of orders certified under CMP regulations and is familiar with the application of these rules to most steel supply problems. He will do everything possible to help you.



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UNITED STATES STEEL

New Materials and Equipment

machines and lathes, or refrigerants, with the exception of methyl chloride.

Said to cost substantially less per foot than copper and less than other strong aluminum alloys, the tubing, if desired, can be had in lengths up to 1000 ft or more, depending on size.

Other advantages claimed for the new product are: it has good flaring and forming characteristics; bends more easily than annealed copper and work hardens less under repeated bending; has excellent resistance to vibration and high resistance to corrosion in many exposures, including industrial and sea coast temperatures; improves in mechanical properties at subzero temperatures, even as low as —320 F.

Rust Preventative Paint Dries in Ten Minutes

An improved formula of its Certified Rust Inhibitor No. 425 has been announced by *United Laboratories, Inc.*, 16801 Euclid Ave., Cleveland 12.

Outstanding features claimed for this new paint are: it will dry in 10 min under normal drying conditions, and one coat provides excellent hiding of the old metal surface. This latter feature is said to cut painting costs up to 50%. The new formula, Rust Inhibitor No. FD-425, will withstand temperatures from —100 F to 250 F, and is exceptionally resistant to salt air and fumes. It can be applied to damp surfaces, interior or exterior, galvanized metal and new or rusted metal surfaces of all kinds.

The one-coat, fast drying process leaves an attractive, semi-gloss finish and is available in several colors plus aluminum and clear.

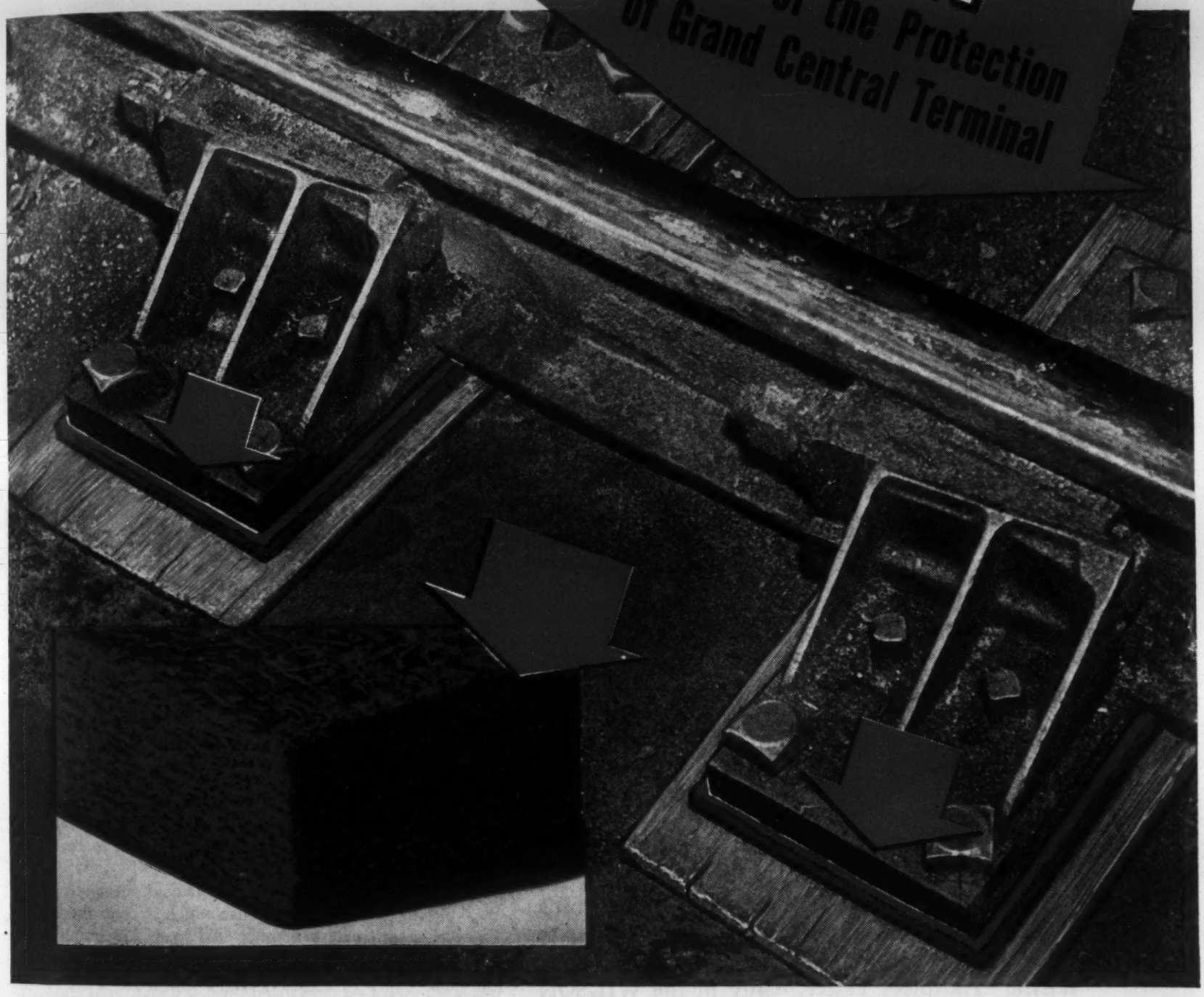
Hardness Tester Adaptable to Special Tests and Vickers Measurements

Introduced in the United States for the first time by *Metallurgical Instrument Co.*, 2454 W. 38th St., Chicago, the Officine Galileo universal hardness tester is said to be especially designed for Rockwell and Brinell hardness tests.

The new tester gives hardness measurements following the Rockwell method on any type metal in the Rockwell A through

Close-up of tie plate and felt pad. The facilities of Grand Central Terminal are shared by The New York Central and the New York, New Haven & Hartford, two of America's great railroads, serving our five plants.

FELT
is part of the Protection of Grand Central Terminal



● Passengers who use the famous Grand Central Terminal in New York City never know that they are riding on felt, but such is the case. Felt pads are installed under the tie plates that hold the rails to the ties. Felt is used here to lessen the transmission of vibration to the structure of the Terminal, which has tracks on two levels, one above the other. In this application, felt probably meets its most severe test in vibration control. Another function of the felt is to reduce noise. Felt by American serves perfectly here, and lasts amazingly long, even under loads running as high as 25,000 pounds on each electric locomotive driving wheel. Replacements have been due chiefly to changes in rails and in tie plate design—the felt in some cases actually lasts as long as the steel rails!... If you have a problem in vibration control, get in touch with American Felt or any of its Sales Offices.

American Felt Company
TRADE MARK

GENERAL OFFICES: 24 GLENVILLE RD., GLENVILLE, CONN.—ENGINEERING AND RESEARCH LABORATORIES: GLENVILLE, CONN.—PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, Montreal.

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1 Totally enclosed, dirt and dust-proof "Zerominder" dial gauge

2 Gripsel clamp screw for quick change and proper seating of penetrator

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4 Enclosed, easy-to-reach variable speed dash pot

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J-Model
"ROCKWELL" Hardness Tester

5 Important "ROCKWELL"* Features

You can be *sure* of the hardness of incoming metals and the various parts or products you ship to your customers if you use a WILSON "ROCKWELL" Hardness Tester. Only in the WILSON will you find these five important features which assure accuracy and ease of operation.

There are two types of WILSON "ROCKWELL" Hardness Testers . . . Regular and Superficial. They come in many styles with accessories for testing flats, rods, rounds, and odd shapes. For micro-indentation hardness testing, there is the WILSON TUKON.

Write for information and let us make recommendations.

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ACCO

WILSON MECHANICAL INSTRUMENT DIVISION
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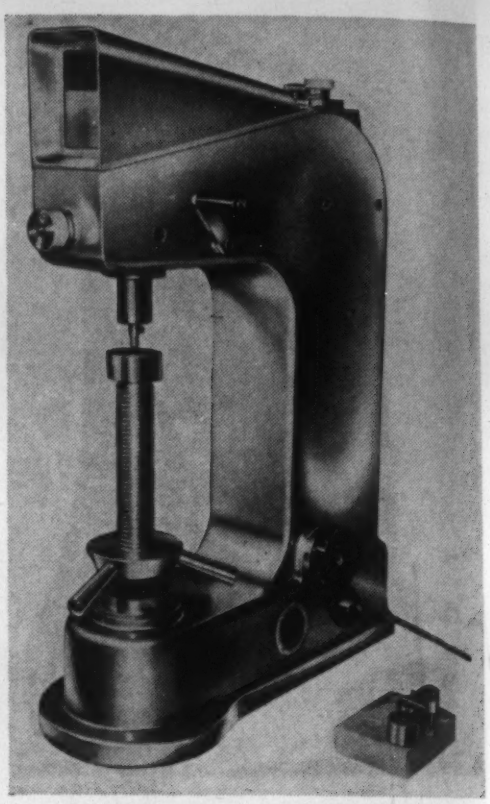
230-E Park Avenue, New York 17, N. Y.

WILSON "ROCKWELL" and TUKON Hardness Testers

New Materials and Equipment



This hardness tester is especially designed for Rockwell and Brinell hardness tests.

F scales by direct reading. Operation of the tester is extremely simple, and readings are easily taken. The tester makes use of a lever arm supported on knife edges and projects a magnified image of the hardness reading on a screen. This optical balance maintains its calibration over extended time intervals and is claimed to be highly accurate.

Loads are interchanged automatically by a patented device which is controlled by an external knob. All loads are obtained by weights which insure absolute constancy of calibration. A built-in oil damper regulates the speed with which the load is applied, and an external screw adjusts the speed.

Vickers measurements at 30 kg can be taken by using a pyramid diamond penetrator and a special microscope to read the diagonals of the Vickers impression. Included as standard equipment are two test specimens, four anvils and two steel ball penetrators.

High-Speed Press for Top or Bottom Transfer Molding

The new Stokes Model 727, a high-speed hydraulic press manufactured by *F. J. Stokes Machine Co.*, 5500 Tabor Rd., Philadelphia 20, is said to have a wide range of applications, including deep draw

Check the advantages of melting and remelting quality steel with TOCCO Induction Heating

Several TOCCO melting furnaces may be operated from one TOCCO high-frequency power source.

- ✓ Extremely Rapid Melting
- ✓ High Efficiency on Intermittent Operation
- ✓ Good Mixing because of Natural Agitation
- ✓ Extremely Low Alloy Loss
- ✓ High Reproducibility of Results
- ✓ No Carbon Pick-up
- ✓ No Contamination when Composition of Charges is Changed
- ✓ Minimum Space Requirements
- ✓ No Special Installation Charge
- ✓ Simple, Safe Operation
- ✓ Clean, Comfortable Working Conditions

If any of these advantages suggest economies in your operations write us for full details—no obligation, of course.

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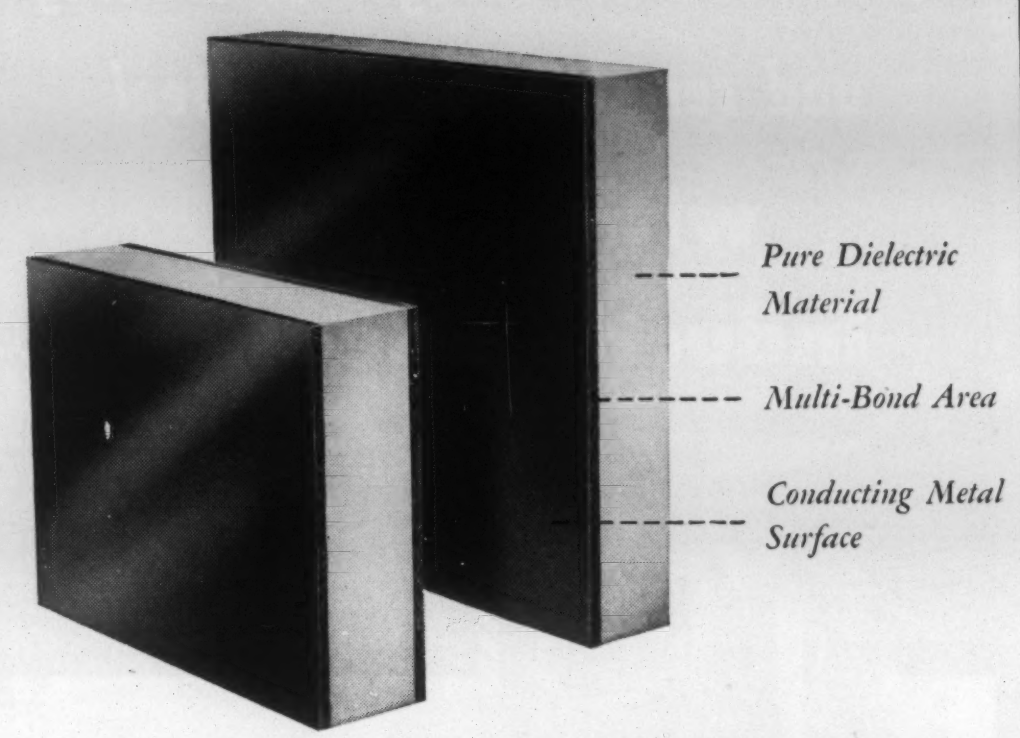
CHEMELEC MULTI-BOND



Metal Faced TEFLON*

● Here is the answer to the bonding and hermetic sealing of dielectric materials to metal components.

Chemelec Multi-Bond is metal faced pure or filled TEFLON, produced by an exclusive (patents pending) method of uniting fluorocarbon resins and metals with an interlocking bond unaffected by severe mechanical shock, vibration and unequal rates of thermal expansion.

The bond is micro-crystalline in structure and gradually changes from dielectric to metal, the conducting metal surface being applied by electro-deposition or other conventional means.

Facing metals include practically all the ferrous and non-ferrous metals, the ferro magnetic group and the precious metals.

Sheets are available, metal faced on one or both sides, in thick ness from .034 to 1.75 in. and in sizes up to 36 in. square.

Write for Bulletin MI-424.

**du Pont's trademark for its tetrafluoroethylene resin.*

UNITED STATES GASKET COMPANY

FLUOROCARBON PRODUCTS DIVISION

656 N. 10TH STREET, CAMDEN, N.J.

FOREMOST FABRICATORS OF "TEFLON" AND OTHER FLUOROCARBON PLASTICS

New Materials and Equipment

work. Useful for either a one-press installation or as an addition to an existing line, it is available with either top or bottom plunger to suit the user's transfer molding requirements. It has an extra-long transfer stroke which permits complete withdrawal of the plunger from the loading area to give ample clearance for loading preforms.

Double pumps are supplied, and since each cylinder has its own pump and controls, the pressures and speed of each can be adjusted separately. Both top and bottom ejection molds can be accommodated.

The molding cycle is controlled by Stokes patented bar-type controller, which provides automatic cycle control through simple movement of buttons on graduated bars. The controller can be reset while the press is in operation. A single electric timer is sufficient.

Another feature of the press is a three-speed controlled closing which is said to reduce closing time of the press and eliminate potential mold damage. The initial ram approach is at high speed, with a slower intermediate approach and final closing only as fast as the material plasticizes. Molded parts are of high density and uniformity, and pieces with projections and small pins are easily produced.

Optional features available include: hot plates for either steam or electric heating; equipment for automatic steam heating and water cooling of molds; and adjustable head with or without longer tie rods.

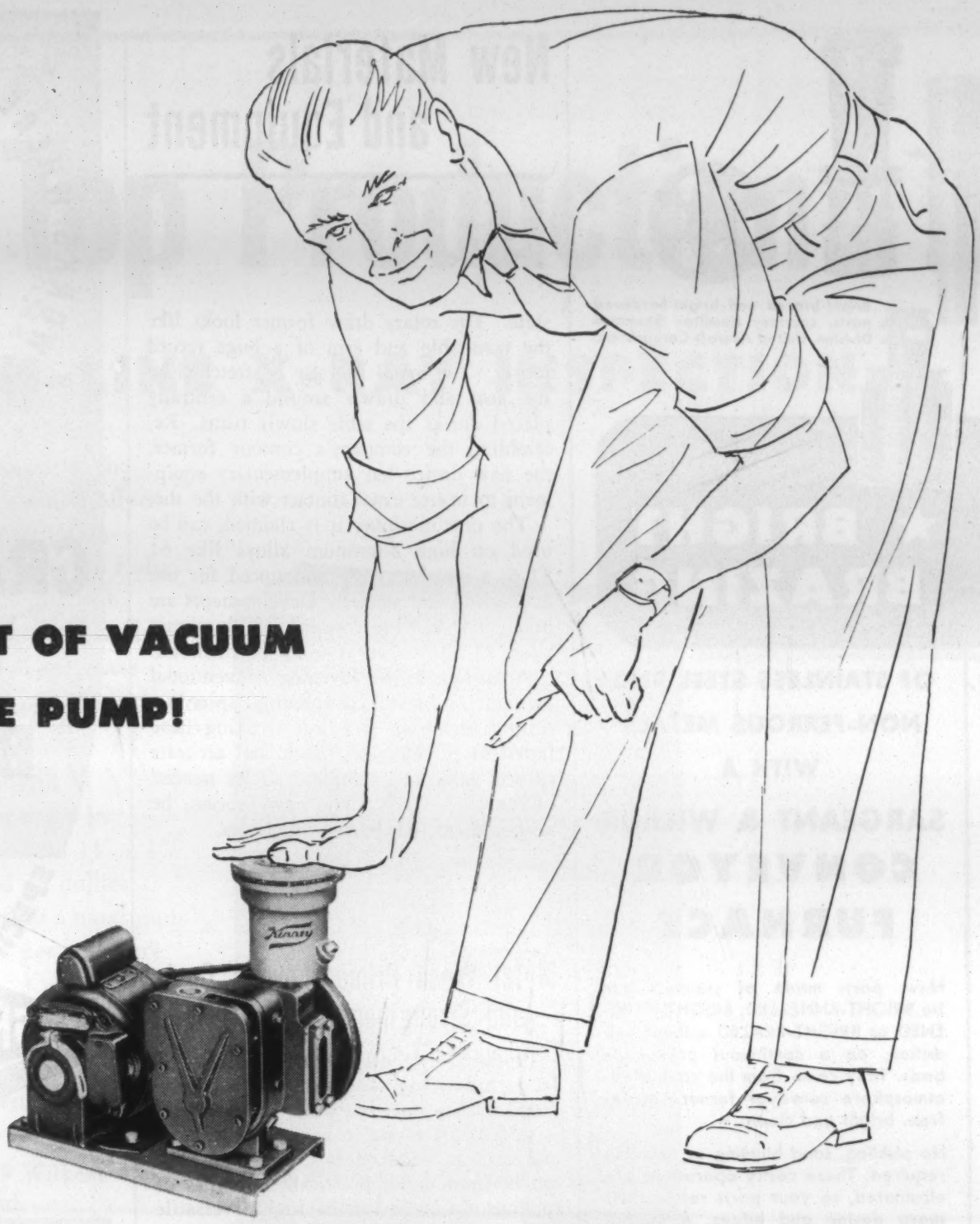
New Draw Former Speeds Jet Plane Production

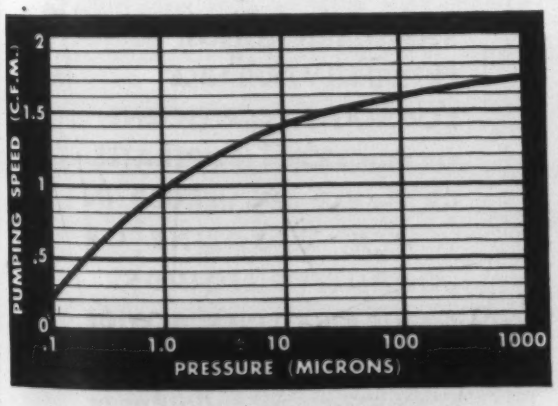
A new Rotary Draw Former, devised and patented by *Cyril Bath Machinery Co.*, 6984 Machinery St., Cleveland, for jet plane production has been unveiled and is currently on order by top manufacturers. The machine, produced in sizes from 12½ to 100 tons, is said to be able to mold the newest tough metal alloys specifically designed to withstand terrific temperatures generated in the tails of the newest and still unflown jets. Such metals as Inconel, Haynes Stellite, vanadium and titanium alloys have been processed successfully on the device, according to the company's president. Titanium in its purest form now is being experimented upon.

The newest company invention utilizes the now widely used Bath method of shaping metals in a stretched and unheated

(Continued on page 162)

THERE'S A LOT OF VACUUM IN THIS LITTLE PUMP!





Look at Kinney Vacuum Pump Model CVM 3153. It's small, yes — only about a foot high. It weighs only 70 lbs. complete with its ¼ HP motor.

Now take a look at its performance curve. See how it starts out with a free air displacement of 2 cu. ft. per min. See how large a percentage of its vacuum "pulling-power" is retained right down to the less-than-1 micron zone.

This is what you buy when you get a Kinney Model CVM 3153 — HIGH PUMPING SPEED. And this is why so many laboratories, so many production operations, so many vacuum service and test jobs are depending on this new Kinney Vacuum Pump. Send coupon for complete details and price. KINNEY MANUFACTURING CO., Boston 30, Mass. Representatives in New York, Chicago, Cleveland, Philadelphia, Los Angeles, Houston, New Orleans, San Francisco, Seattle, and foreign countries.

Kinney
VACUUM PUMPS

Kinney Manufacturing Co.
3523 Washington St., Boston 30, Mass.

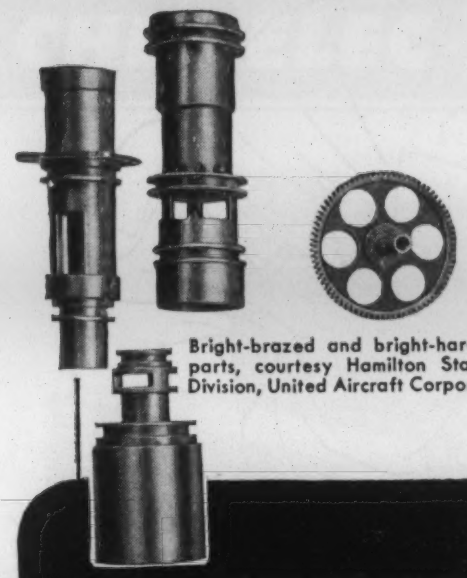
Please send me Bulletin V51-A describing the new Kinney CVM 3153 Midget Vacuum Pump and price information.

Name.....

Company.....

Address.....

City..... State.....



Bright-brazed and bright-hardened parts, courtesy Hamilton Standard Division, United Aircraft Corporation.

★ BRIGHT BRAZING

OF STAINLESS STEEL AND NON-FERROUS METALS WITH A

SARGEANT & WILBUR CONVEYOR FURNACE

Now, parts made of stainless can be BRIGHT-ANNEALED, BRIGHT-HARDENED or BRIGHT-BRAZED without oxidation, on a continuous production basis. They come from the controlled-atmosphere conveyor furnace scale-free, bright and clean.

No pickling, sand blasting or tumbling required. These costly operations are eliminated, so your parts retain their sharp design and edges. A special Sargeant & Wilbur alloy for bright-brazing makes the joint practically invisible because it resists dulling and matches the metal color perfectly. Steel and non-ferrous metal parts are brazed in the same operation with excellent results.

Bright ANNEALING HARDENING AND BRAZING STAINLESS STEEL

SARGEANT & WILBUR, Inc.

Your samples processed FREE. To see your products bright-brazed, send samples and specifications.

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NEW YORK CITY and PENNSYLVANIA Gerald B. Duff, 68 Clinton Ave., Newark, N. J.; MICHIGAN and NORTHERN OHIO M. C. Schwer, 2970 W. Grand Blvd., Detroit 2, Mich.; NEW ENGLAND James J. Herkis, 182 Weeden St., Pawtucket, R. I.

New Materials and Equipment

state. The rotary draw former looks like the turn-table and arm of a huge record player. The metal literally is stretched by the arm and drawn around a centrally placed die as the table slowly turns. Resembling the company's contour former, the new device has supplementary equipment to insure exact contact with the die.

The new machine, it is claimed, can be used on high aluminum alloys like 61 ST-6, a metal recently announced for use in conventional aircraft. Developments are under way for the forming of aluminum alloy 75 ST, toughest alloy of them all.

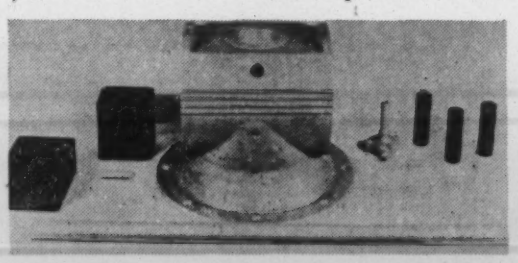
According to the inventor, conventional methods of metal processing, spinning, rolling, stamping and heat working have failed to produce the tough and accurate curved parts and complete circles needed of the high alloys. The new process, he said, adds to the desired toughness.

Metal Wash Primer Lowers Costs and Strengthens Service Life

Produced by the *Vorac Co.*, Rutherford, N. J., a new high adhesion, anti-corrosion metal wash primer based on Vinylite resin is said to fill a vital role in both military and civilian production. The compound can be used under practically all types of coatings. Claimed to be highly versatile in formulation and application, the wash primer requires no oxidation or polymerization, as films are formed merely by the evaporation of solvents.

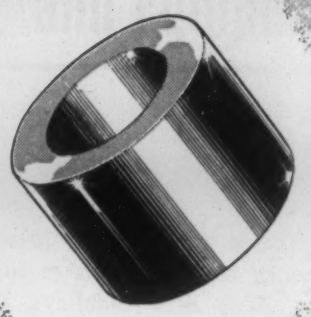
A zinc chromate compound, Vinylite resin-base wash is designed to provide an adherent base coating on most metals and alloys. Under most climatic conditions it will dry in less than 30 min. It is a metal conditioner as well as primer, applied only to clean surfaces, since it does not replace degreasing or sand blasting. It does, however, replace phosphate treatment and should not be applied over a phosphate surface.

Wash primer is always employed in conjunction with one or more top coats. Used



Transformer cases, gear housing tops and closures; housing for electronic unit, gear housings, aeronautical and electrical parts, battery cases, and a tubular piece of a hospital walker all employ the new wash primer.

WORKS WHERE OTHERS WON'T



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SPECIFY GRAPHALLOY TRADE MARK REG. U. S. PAT. OFF. WITH CONFIDENCE

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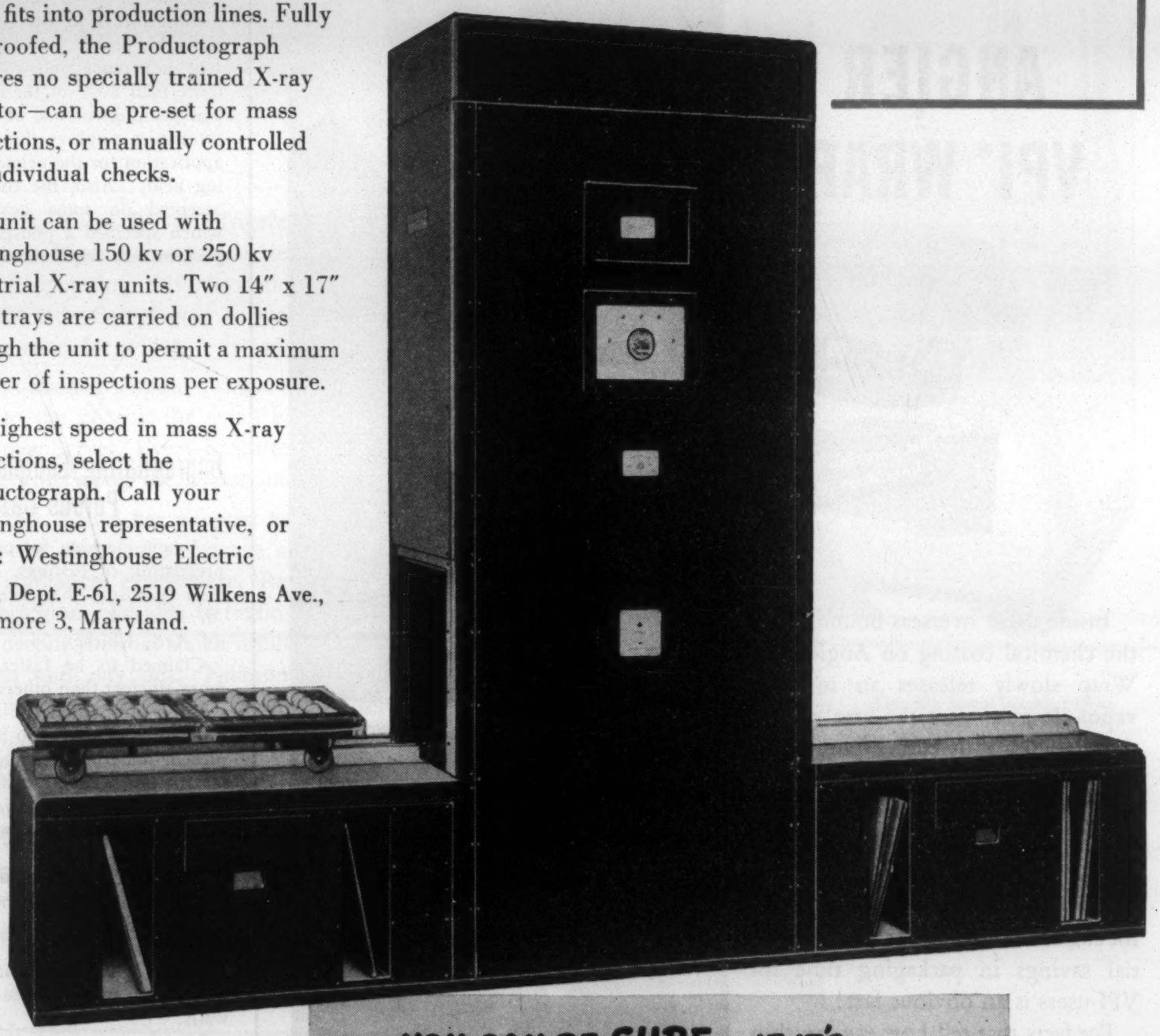
For Top Production:

IN-LINE X-RAY INSPECTION

For mass inspection of parts, the Westinghouse Productograph offers safe, speedy X-ray examination—easily fits into production lines. Fully ray-proofed, the Productograph requires no specially trained X-ray operator—can be pre-set for mass inspections, or manually controlled for individual checks.

This unit can be used with Westinghouse 150 kv or 250 kv industrial X-ray units. Two 14" x 17" parts trays are carried on dollies through the unit to permit a maximum number of inspections per exposure.

For highest speed in mass X-ray inspections, select the Productograph. Call your Westinghouse representative, or write: Westinghouse Electric Corp., Dept. E-61, 2519 Wilkens Ave., Baltimore 3, Maryland.



J-08261

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INDUSTRIAL X-RAY

Vapor Stops Rust

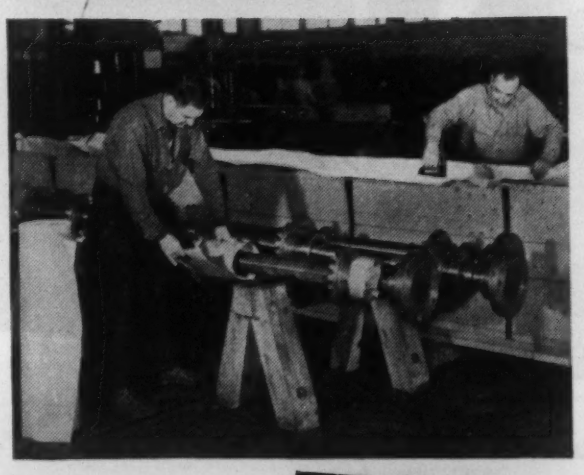
for Exporter of Rolling Mill Parts

Now slushing costs are *eliminated* . . . and Packaging time is cut with . . .

ANGIER VPI* WRAP

Inside these overseas-bound crates the chemical coating on Angier VPI Wrap slowly releases an invisible vapor. It permeates the area around these rolling mill parts . . . prevents rust almost like magic! So effective is this proven vapor rust preventive that rejects due to rust are eliminated. Slushing in grease or oil is not necessary—this means "cleaning" costs for customers are eliminated! Substantial savings in packaging time for VPI-users is an obvious fact!

For facts that tell how *you* can ship and store metal articles or parts RUST-FREE at less cost . . . write today to:



*Reg. U. S. Pat. Off. Vapor rust preventive

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Framingham 14, Mass.
Industrial Packaging Engineers since 1895
Representatives and Distributors in Principal Cities

Angier Corp.,
Framingham 14,
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Yes

Send case studies of your revolutionary vapor rust preventive TO:

New Materials and Equipment

as soon as possible following metal cleaning, the primer will for a time prevent rusting under usual weather conditions if the top coating is not immediately applied.

Vorac H-400 (U. S. Spec. MIL-P-153-28) is supplied in two parts for mixing at the time of use. The primer is applied by dipping, brush or spray, depending on the objects to be coated.

According to the company, electronic parts for three of the largest aeronautical manufacturers in the country are primed with this primer, and because of its excellent adherence and corrosion resistance, more than 80% of the metal conditioning and priming for one of these aeronautical companies employs this primer. Another application for the primer is in the recording field. Also, the compound has been accepted on some government material which specified a phosphate base meeting performance requirements handily.

Impregnating Equipment Eliminates Porous Castings

A new machine for production line impregnating of castings, said to eliminate their porosity, has been announced by *Metallizing Co. of America,* 3520 W. Carrol Ave., Chicago 24.

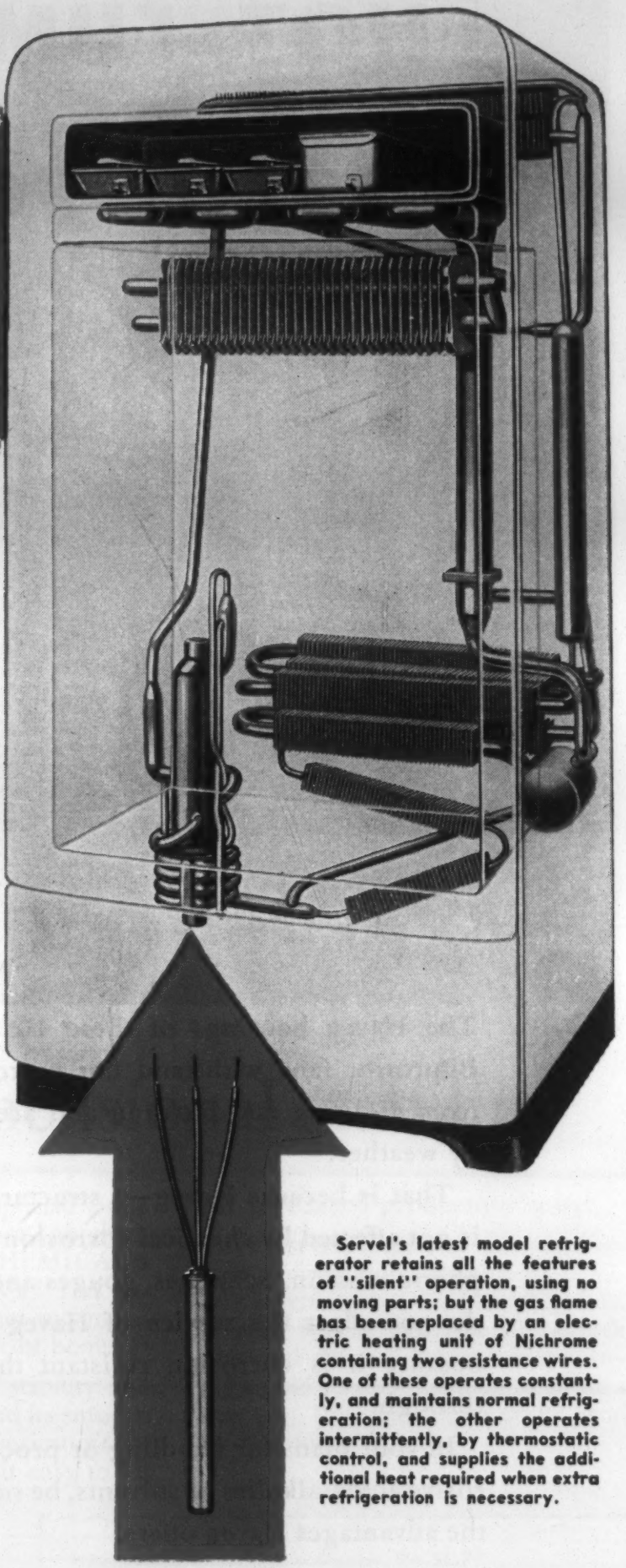
Claimed to be faster, less costly and more efficient than others now on the market, the unit called the Model M-30 Mogullizer, is designed to help overcome the present material shortage by sealing both leaking and weeping castings—ferrous and nonferrous—under a high vacuum.

Operation of the new unit is efficient and positive, with no fixtures required. Castings to be impregnated must only have a minute porosity, fissures or pinholes present. Placed in the unit's sealing tank, they are first subjected to a 29½-in. vacuum (highest in the field) for 20 min., removing all air and moisture from their inner walls.

Next, an impregnating solution, such as the Mogul Cast Seal Colloidal, is introduced into the vacuum tank covering the castings. This is followed by application of 100-lb. air pressure for another 20 min, forcing the solution into the casting walls from all directions. When the remaining solution is withdrawn to its tank, the castings are removed and rinsed in plain water. No further operation is said to be needed for sealing Mogallized castings.

According to the manufacturer, pressure castings sealed by this process have been subjected to severe tests with such solutions as hot oil or kerosene under pres-

Servel goes electric with NICHROME*



Servel's latest model refrigerator retains all the features of "silent" operation, using no moving parts; but the gas flame has been replaced by an electric heating unit of Nichrome containing two resistance wires. One of these operates constantly, and maintains normal refrigeration; the other operates intermittently, by thermostatic control, and supplies the additional heat required when extra refrigeration is necessary.

Now the famous silent Servel refrigerator operates on electricity. In the new refrigerator, a simple electric heating element provides heat for operating this absorption-type system. Just plug it in, and the new Servel goes to work . . . provides the *soundless* performance for which it is famous.

Since cold is obtained without a single moving part by means of heat applied to the system, the small heating element is the vital part of the new Servel. Every operation of the refrigeration cycle, indeed, depends upon the heater unit *staying on the job.*

Because of this, Servel has adopted heating elements made with Nichrome—the electrical resistance alloy that is the very heart of quality appliances everywhere. Remarkably resistant to high heat and corrosion, and able to retain its physical and electrical properties despite thermal shock resulting from intermittent operation day in and day out, Nichrome assures Servel of efficient operation and a lifetime of dependable service.

Whatever *your* requirements for electrical resistance material, it will profit you to consult with us. In addition to world-famous Nichrome and Nichrome V, we produce over 80 alloys to meet the varied needs of the electrical and electronic fields. Although strategic materials and the alloys we make from them are on strict allocation at the present time, we'll be pleased to serve you to the best of our ability.

SPECIAL PURPOSE ALLOYS SINCE 1870 — D/H — TRADE MARK REG. U. S. PAT. OFF.

Driver-Harris Company

HARRISON, NEW JERSEY

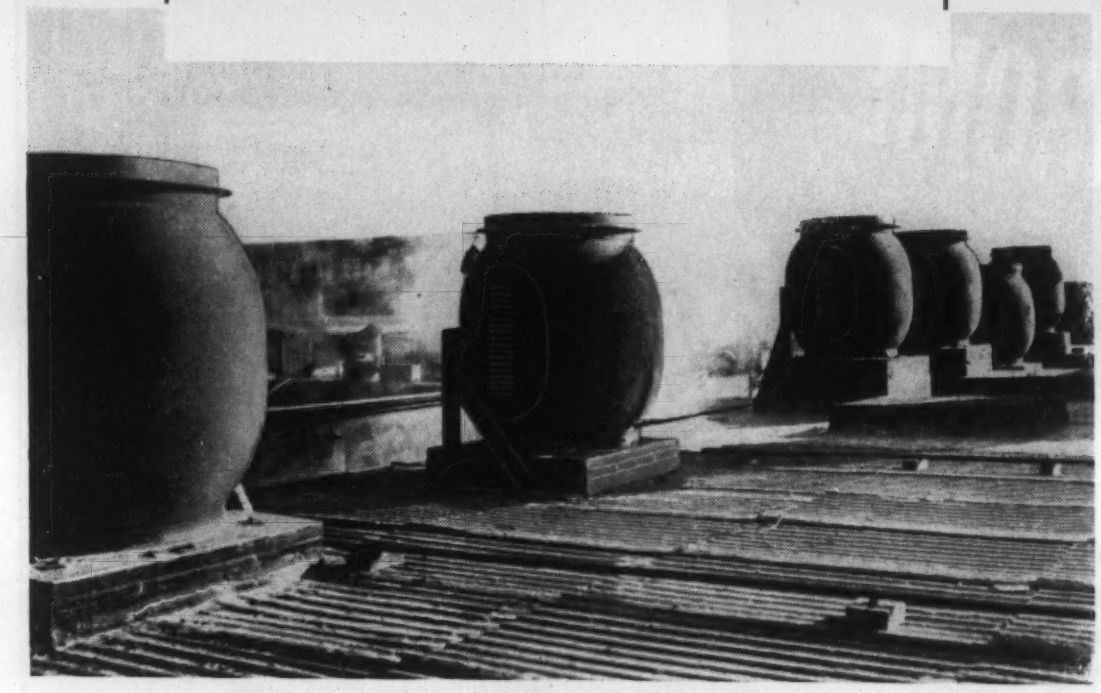
BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco

In Canada: The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

* T. M. REG. U. S. PAT. OFF.

MAKERS OF THE MOST COMPLETE LINE OF ELECTRIC HEATING, RESISTANCE, AND ELECTRONIC ALLOYS IN THE WORLD

HOT FUMES OR DAMP FOG



it's all the same to HAVEG!

The Haveg housings of these 10 DeBothezat Bifurcator fans withstand hot corrosive fumes from cleaning and pickling and are unaffected by weather.

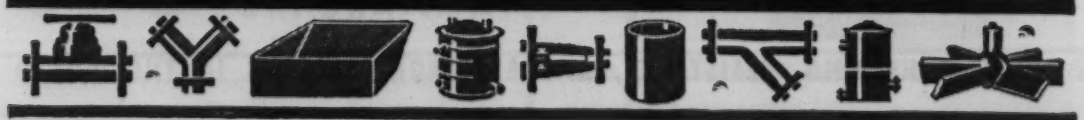
That is because Haveg—a structural plastic—is not affected by chemical corrosion nor atmospheric erosion. Scratches, gouges and abrasions do not affect the service of Haveg equipment because it is corrosion resistant through and through.

In your plans for handling or processing corrosive acids, alkalies or solvents, be sure to check the advantages Haveg offers.

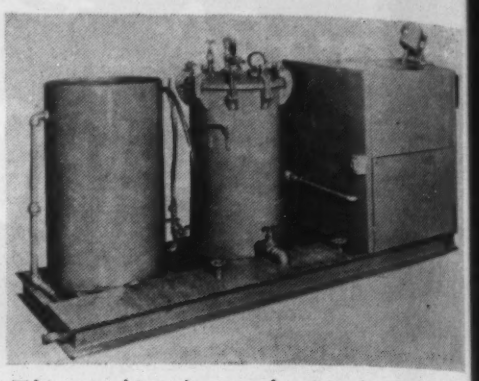
Write for Bulletin F-6.

HAVEG CORPORATION
NEWARK, DELAWARE
FACTORY: MARSHALLTON, DEL. · TEL. WILMINGTON 3-8884

CHICAGO 11	CLEVELAND 14	HARTFORD	HOUSTON 6	DETROIT 11	LOS ANGELES 13	SEATTLE 1
1201 Palmolive Bldg.	550 Leader Bldg.	57 Farmington Ave.	4601 Montrose Blvd.	2832 E. Grand Blvd.	601 W. Fifth St.	Vance Bldg.
Delaware 7-6266	Cherry 7297	Hartford 64250	Jackson 2-6065	Madison 1575	Mutual 8955	Eliot 0890



New Materials and Equipment



This machine for production line impregnating of castings is designed to overcome the present materials shortage by sealing both leaking and weeping castings—ferrous and nonferrous—under a high vacuum.

sures as high as 10,000 psi. Cost of castings is said to vary from 1/5 of a cent to 3c per lb, depending upon their bulk.

The M-30, one of four models, has a capacity of 4½ cu ft. It is a complete unit, comprising a vacuum pump, sealing, rinsing and supply tanks, heating element and power supply, and all fittings and controls.

Flame-Sprayed Stop-Offs for Plating

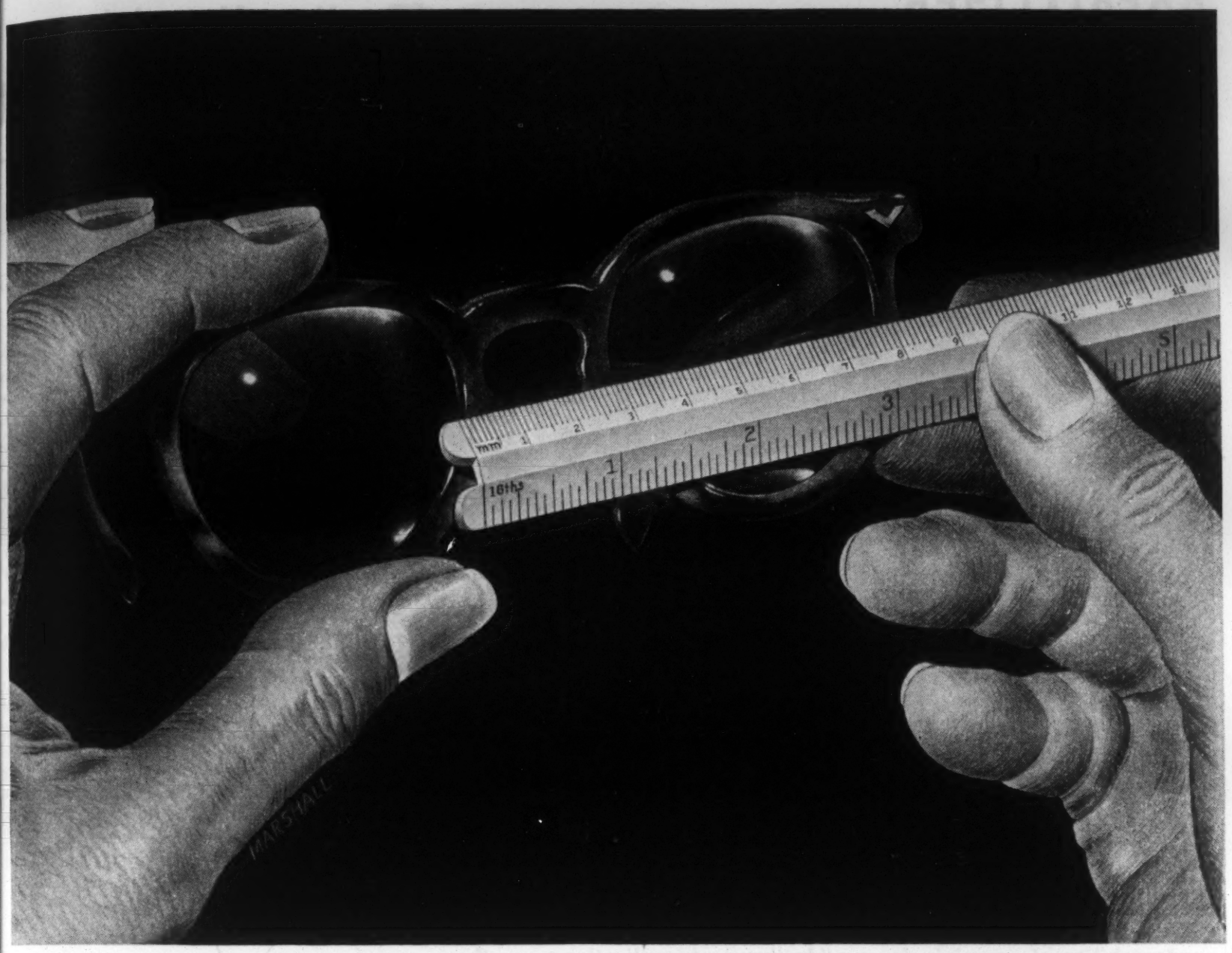
A new and extremely economical method of masking portions of metal articles to be plated has been developed by the *American Agile Corp.*, P. O. Box 168, Bedford, Ohio.

Instead of covering the sections which are not to be plated by the conventional methods, such as lacquering or tape masking, a completely nonporous and chemical inert coating of polyethylene (about 1/16 to 3/32 in. thick) is flame sprayed onto the section to be masked. To allow the initial removal of the stop-off mask for re- to be masked is covered with a thin coating of a special mold release agent prior to spraying.

Due to the inherent elasticity and chemical inertness of polyethylene, these stop-offs are removed from the plated parts and then replaced onto those to be plated a great number of times by simply snapping them off and on the part to be plated.

Flame-sprayed polyethylene stop-offs are said to result in enormous labor and material savings to the plater by eliminating the tedious and time-consuming operation of masking and unmasking each individual part.

The company offers the flame spray equipment for making stop-offs by the individual plater as well as polyethylene plating stop-offs made to customer's specifications.



Optician's Rule made by Sadler Brothers, Inc., S. Attleboro, Massachusetts

A new measure of dimensional stability

How would you like to see *all* these qualities in *your* product?

Die shrinkage so low you can mold accurate measurements right into your product!

Real dimensional stability that keeps it the way it was made—no warping, swelling, or shrinking!

Toughness and rigidity that make it stand up under the hardest use!

The makers of this optician's rule wanted all these qualities—and got them with **NAUGATUCK CHEMICAL'S KRALASTIC D-IVORY!** This unusual styrene copolymer not only measured up—it gave important bonuses!

It had high chemical stability and resistance to moisture. **And its smooth surface licked the once serious problem of rejects—made it easy to fill in line work without danger of smearing!**

All at reduced production costs!

It's just one more case of a manufacturer profiting from Naugatuck Chemical's ingenuity and fine basic materials. It may suggest the role Naugatuck Chemical can play for you, in improving an old product, helping to create a new one. Why not look into it? Send us the coupon below.

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Division of **UNITED STATES RUBBER COMPANY**
NAUGATUCK, CONNECTICUT

BRANCHES: Akron • Boston • Charlotte • Chicago • Los Angeles • New York
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Naugatuck Chemical Plastics Division, Elm St., 12
Naugatuck, Conn.

Without charge, send technical data on properties, uses, handling methods (specify desired end products).

I understand that, from this data, I can order suitable, free experimental samples.

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COMPANY .....

ADDRESS .....

CITY ..... ZONE ..... STATE .....

MARVINOL® vinyl resins • KRALASTIC® styrene copolymers • VIBRIN® polyester resins
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RESEARCH
From STAR laboratories have come an increased knowledge of the adaptability of porcelain for a wide range of applications . . . the development of specific formulae to meet individual needs.

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Competent help in maintaining good ceramic design principles . . . in simplifying production; reducing costs; expediting deliveries.

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Each piece of STAR porcelain is engineered to solve a specific problem—dielectrics, temperature, strength, moisture and others . . . to meet the requirements of your application.

PRODUCTION
Complete facilities include automatic production equipment; machine shop; scientifically controlled processes; rigid testing and inspection methods.

Send for this new STAR brochure containing technical and application data that will help you in specifying the right ceramic for your job.

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★ LAVOLAIN
★ THERMOLAIN
★ VITROLAIN
★ NU-BLAC
★ COMMERCIAL WHITE

The STAR PORCELAIN COMPANY

MUIRHEAD AND JAY AVES. TRENTON, N. J.

New Materials and Equipment

Cold Solder Filler Material Performs Many Jobs

A cold solder filler material for blowholes, fractures in castings, and patterns is currently being offered by *A. L. Okun Co.*, 148-26 58th Ave., Flushing 55, N. Y.

A fast drying cold metal in putty form, the material is said to dry to hard metal in minutes and to adhere to everything. Essentially the process works like this: Powdered aluminum is in a quick drying, non-soluble liquid vehicle. The vehicle evaporates leaving the deposited aluminum in a smooth surface that will not crack, chip, peel or shrink in its recommended service. This material is applied with a putting knife.

Among its many uses are: It serves as a metallic coating on patterns, so a liquid parting can be used; it is applied in filling seams and imperfections in metal assemblies; it can be used for building fillets and producing patterns for precision investment castings; it fills pits, blowholes and fractures in all castings.

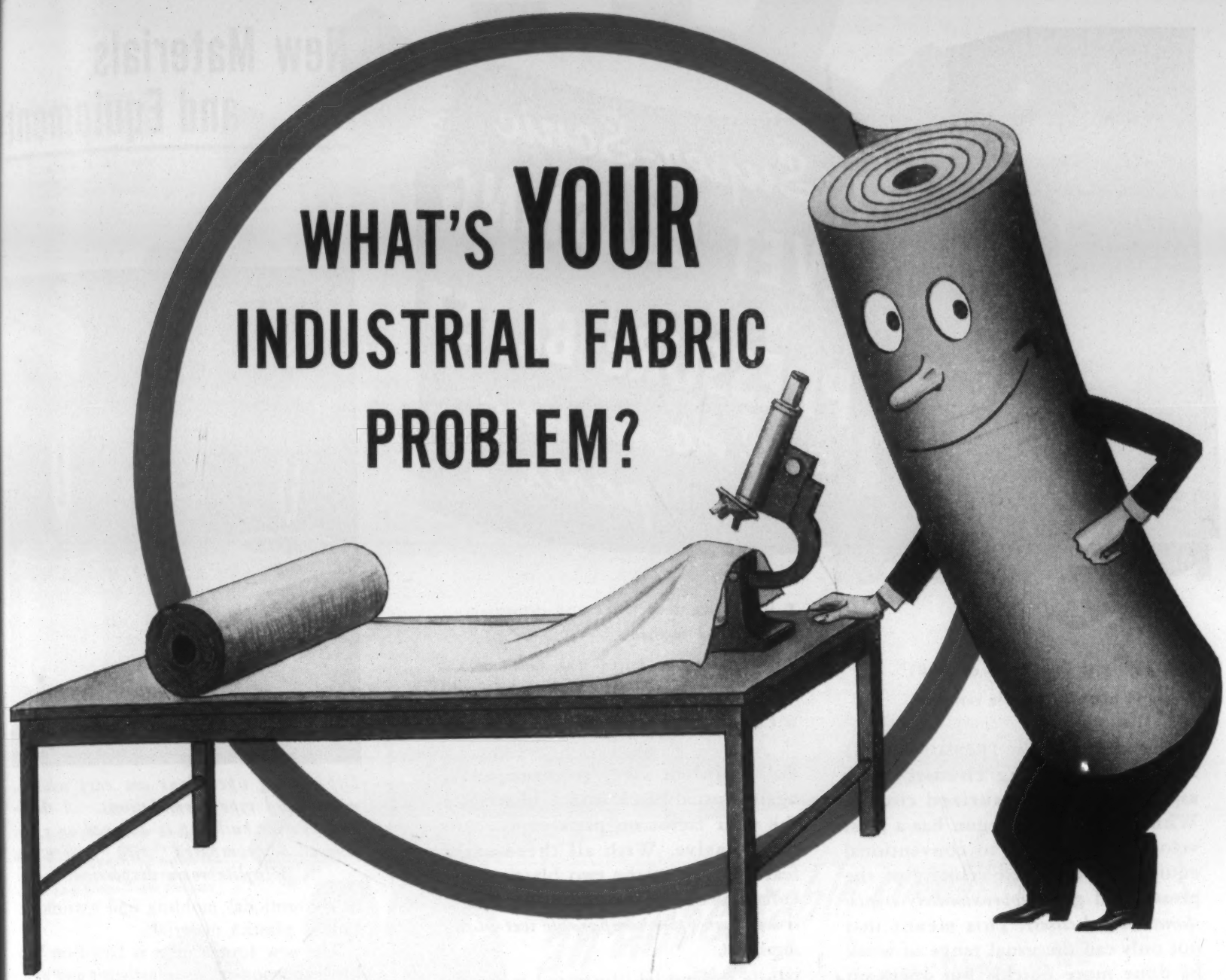
When thinned with a solvent, the cold solder can be brushed or sprayed.

Vinylite Dispersion Resins Opens Many New Fields of Application

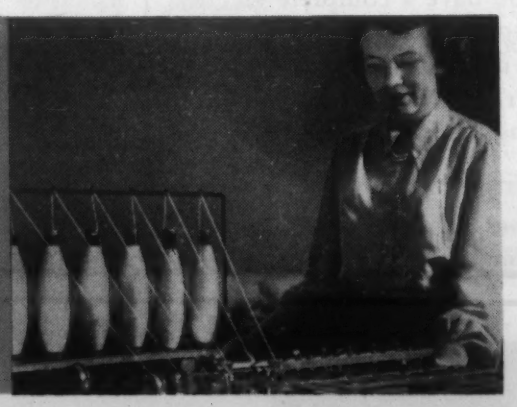
A new formulation of Vinylite dispersion resins has been developed by *Bakelite Co.*, 122 E. 42nd St., New York 17, which is said to make possible a plastic material that opens up many new fields of application, combining the advantages of production and equipment economies.

Known as Plastigels and made of Vinylite resin, the new material can be molded, calendered, embossed, stamped and extruded. It can be used for coating cloth, paper and dip-coating of wire objects, and is particularly suited for floor tile, tubing, intricate electrical fittings, toys, novelties, and a wide variety of other uses.

Plastigels resemble putty in consistency in their raw state. Relatively stiff, they can be quickly softened at room temperature by stirring or kneading, and formed by hand pressure, molds or dies into complicated shapes and fine details. After forming, Plastigels gradually stiffen again, becoming self-supporting. They bake to a hard, finished state in about 10 to 15 min. at only 350F without sagging, shrinking or otherwise losing their formed shapes. One of the most important advantages of the new materials is that they can be handled with lighter weight equipment than is used



Need some expert advice on the right fabric for your special needs? Want a new fabric developed for a particular purpose—or an existing fabric adapted to a new application? We believe you'll find Mt. Vernon-Woodberry has the skill and experience it takes to work it out. Can we help?



One of a series of comprehensive laboratory controls throughout production to assure uniformity in all Mt. Vernon-Woodberry products. The unit shown automatically tests 6 strands of yarn at one time.

STANDARD FABRICS

White, Sail and Army Duck
Double and Single Filling
Hose-Belting and Shoe Duck
Filter Cloths
Dryer Felts
Narrow and Wide Drills
Twills

AT YOUR SERVICE

Mt. Vernon-Woodberry Mills' staff of textile engineers is available on request to help you with your problems in development or application of industrial fabrics.

FABRICS BUILT TO SPECIFICATIONS

For Calendering, Laminating and Other Industrial Applications

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TURNER HALSEY COMPANY
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- Finishing to tolerances of .0001"
- Tough heat treat scale removal
- Deburring deep holes and intricately-machined recesses
- Surfacing to a micro-inch finish of 2
- Pre-plating and pre-painting cleaning
- Controlled stock removal

Featured in the new PRESSURE-BLAST are *two* wet-blasting circuits — the aspirating and pressurized circuits. While the aspirating gun has a blast velocity comparable to conventional equipment, the blast velocity of the pressurized gun *approximately triples standard velocities!* This means that not only can the usual range of work be done more quickly but opens up entirely new fields within the metal finishing industry. To demonstrate the effectiveness of the pressurized gun, a perfectly concentric ¼" hole was blasted in plate glass ½" thick with no masking . . . *and in 8 seconds!*

The PRESSURE-BLAST operates with a minimum of downtime — all moving parts, including troublesome circulating pumps, have been eliminated.

Full stainless steel construction . . . against usual black iron . . . eliminates the wear factor on parts exposed to the abrasive. With all these extra features . . . plus the two blasting circuits...the cost of the PRESSURE-BLAST *is less than other comparable wet-blasting units.*

While the model illustrated is manually-operated, PRESSURE-BLAST models are available with rotary barrels for handling small pieces in bulk; roller tables for accommodating heavy molds and dies; indexing or constant-speed rotary tables and conveyorized models for high production rates. We will engineer a PRESSURE-BLAST to meet any production or engineering requirements.

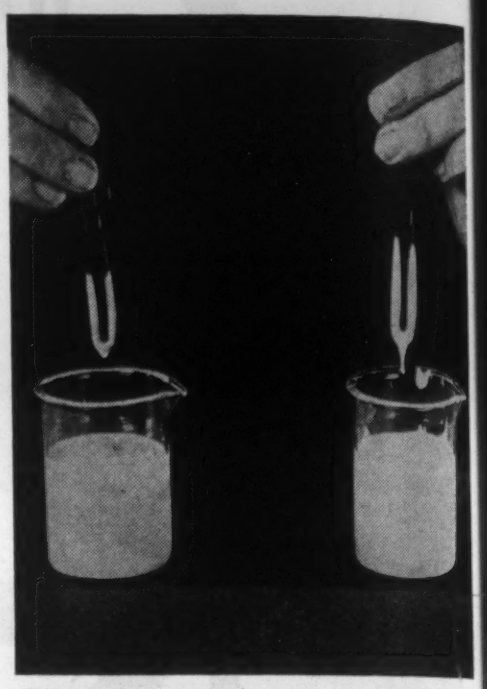
The Cro-Plater 500

With the PRESSURE-BLAST as your preplating cleaning unit and the fully self-contained CRO-PLATER hard chrome plating unit, you have a complete electroplating set-up. Easily installed, the CRO-PLATER needs only a current source and duct outlet and is easily adapted for cadmium, silver, nickel, copper and brass plating. Models available ranging from 50 to 500 amps.

For price and delivery quotations . . . sample work arrangements . . . information regarding custom models . . . write

the CRO-PLATE Company, Incorporated
HARTFORD 5, CONNECTICUT

New Materials and Equipment



Dip-coating operations are easy with the more fluid type formulations. A thicker and heavier build-up is attained on a wire object as compared with conventional Vinylite resin dispersion.

in conventional molding and extrusion of similar plastics materials.

The new formulation is based on Vinylite dispersion resins, plasticizer and an additive of Bentone-34, plus other modifiers and colorants. Bakelite will supply to using companies and commercial formulators the basic Vinylite resins and the technical information required to formulate the Plastigels.

New Metal Offers Interesting Possibilities

The *Foreman Research Laboratory,* P.O. Box 272, Arlington, Calif, has announced the discovery of a new metal, Andrium. Said to be relatively easy to remove from the mother ore, the metal can be burned out about the same as carbon, but it differs from carbon in that it forms long, white needles that readily dissolve into water, making a colorless liquid. This seems to make Andrium easy and inexpensive to produce, but as the metal has the quality of carrying with it small amounts of all other metals with which it is associated, long drawn out chemical separations are necessary to get a fairly high grade product.

The metal, when no air or oxygen is present, can stand almost as much heat as tungsten. It gives purple lights when viewed in sunlight, and appears almost purple black to the eye.

Now that the discovery has been made

Showing a setup of Wales Type "BL" Hole Punching and Type "N" Notching Units for punching and notching in the same operation on a Wales Twin Column Press.

Showing a template setup of Wales Type "H" Hole Punching Units for punching holes in curved and straight flanges and rims on a Wales Twin Column Press.

Showing a Wales Twin Column Press with the Wales Multiple Hole Punching System operating on a press bed.

an unbeatable combination

WALES HOLE PUNCHING AND NOTCHING UNITS and WALES TWIN COLUMN PRESSES

● A typical example of the unique design built into Wales Twin Column Presses is the double crank pull down drive on the pair of ram guides. This feature provides equal pressure on both ends of ram and assures parallel alignment of ram to press bed.

Also this alignment feature works hand-in-hand with the exclusive, independent, self-contained Wales Hole Punching and Notching Units with built-in punches and dies which are held in perfect alignment by holders. In addition, Wales Units do *not* require die sets as nothing is attached to press ram.

Have the complete story *of this unbeatable combination* at your fingertips by writing for fully-illustrated, functionally-colored catalogs TODAY.

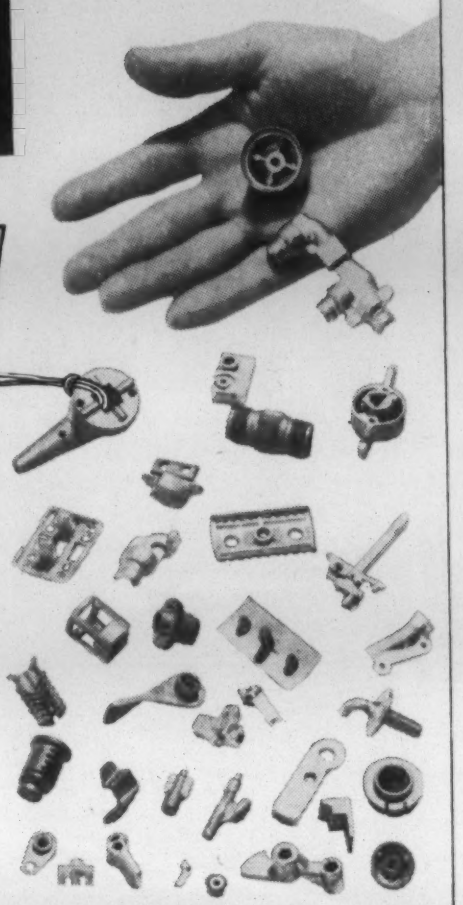
WALES-STRIPPIT CORPORATION
GEORGE F. WALES, *Chairman*
399 PAYNE AVE., NORTH TONAWANDA, N. Y.
(Between Buffalo and Niagara Falls)
WALES-STRIPPIT OF CANADA LTD., HAMILTON, ONTARIO
Specialists in Punching and Notching Equipment

Simple or Intricate

SMALL METAL PARTS

made rapidly, economically

DIE CAST in DOLLIN'S SMALL CASTINGS DEP'T.



SMALL ZINC DIE CASTINGS

1000 per lb. to 3 per lb.*

CHECK WITH US for possible savings on present or projected small metal parts. Our high speed automatic die casting machines permit greater intricacy, super-fast production. Tooling costs and piece prices are low, costly machining and assembly operations are often eliminated. You get completely trimmed, "ready-made" parts quickly, inexpensively! Defense order subcontracting, commercial orders.

Write For Bulletin and Samples or Send Prints for Quotation

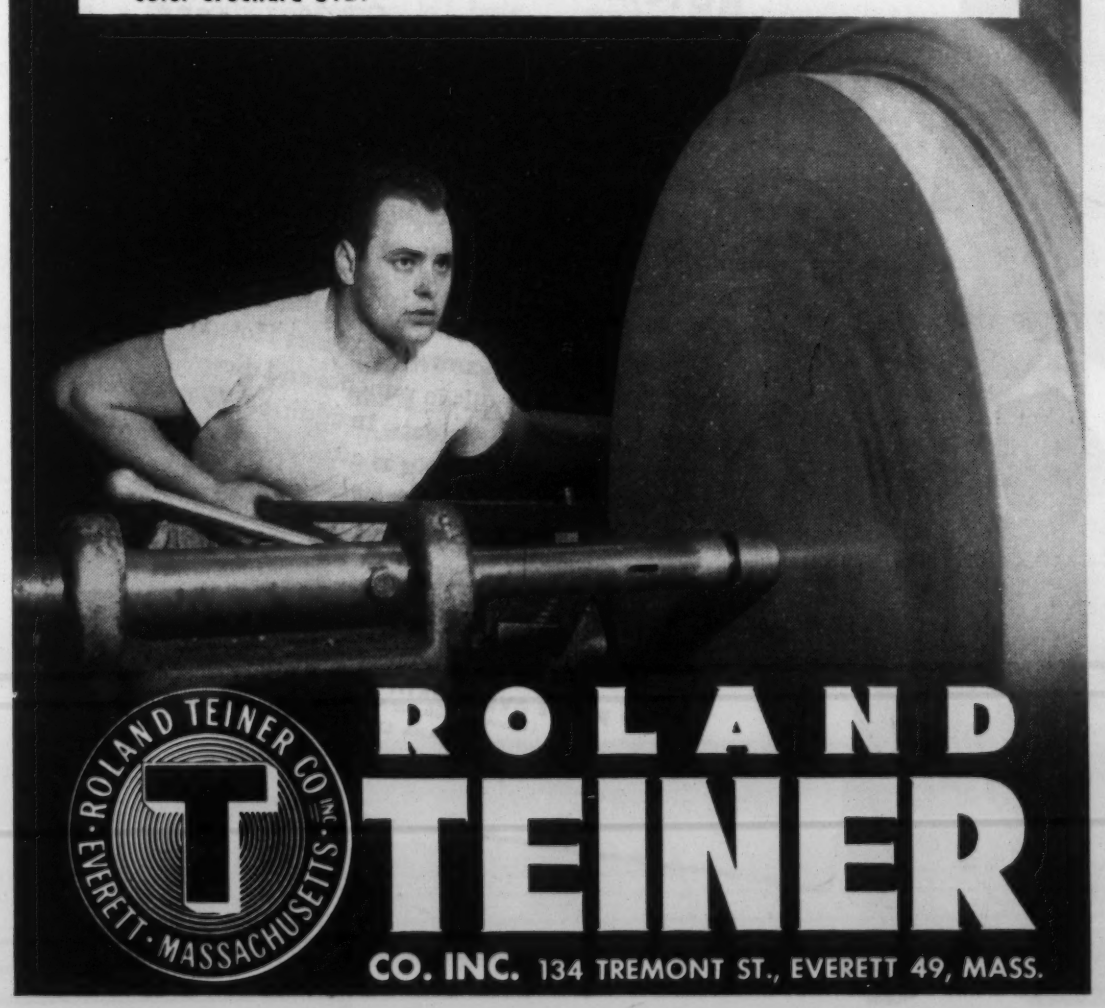
*Approx. range for Small Castings Dep't.

DOLLIN CORPORATION

Zinc & Aluminum Die Castings of All Commercial Sizes

610 South 21st Street, Irvington 11, New Jersey

FILLING AN INDUSTRIAL ORDER. Large aluminum dust cover ready for "spindown" operation on medium-sized spinning machine. An example of the all-gage — all-metal — any quantity — spinning capacity available at Teiner. ***Write for newest color brochure 51D.***



ROLAND TEINER CO. INC. EVERETT MASSACHUSETTS

ROLAND TEINER

CO. INC. 134 TREMONT ST., EVERETT 49, MASS.

New Materials and Equipment

and sufficient material produced on which research can be done, it is predicted that the new metal will have some very interesting possibilities. According to the laboratory it has already been found to harden and give spring action to silver, alter zinc, harden platinum, and to change the crystal pattern of some compounds.

Possible uses predicted are: toughening steels, hardening gold, oxidizer-reducer, catalyst, organic stainer, electronics.

Contour Welding Speeded by New Heliarc Welder

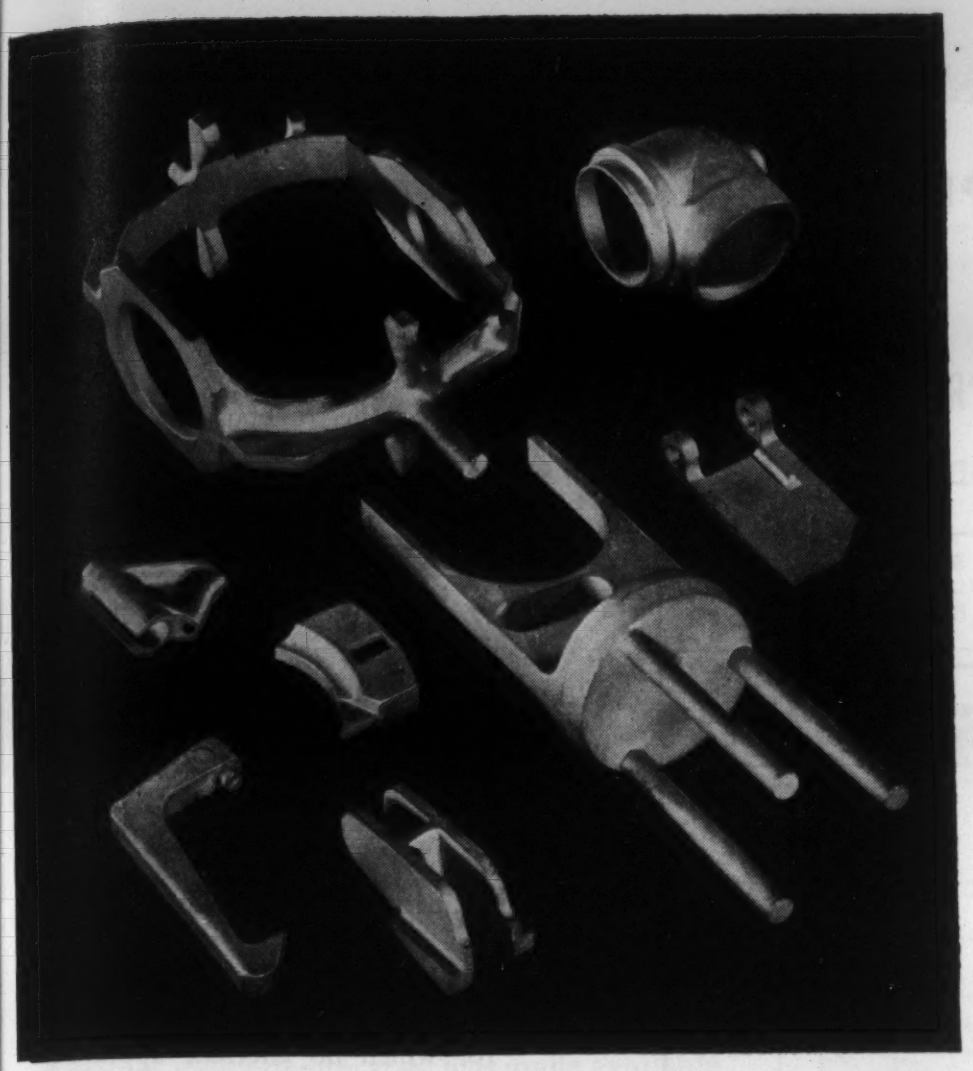
Contour welds that formerly had to be made with manual apparatus can now be made semi-automatically with the new Heliarc HWM-1 welder developed by *Linde Air Products Co.*, Div. of Union Carbide and Carbon Corp., 30 E. 42nd St., New York 17. The new equipment is said to retain all of the flexibility of manual operation and to add to it the obvious advantages of mechanized welding, such as

Contour welds are said to be easy with this Heliarc semi-automatic torch.

uniformity of speed, arc length and weld deposit. High quality welds can be made in sheet metal assemblies at speeds up to 100 in. per min.

The new torch employs a filler rod which is fed automatically by electrically-powered drive rolls through a flexible conduit into the tungsten arc of the torch. The driven filler rod not only serves as weld metal, but also provides a propelling force which moves the torch when the rod is kept in contact with the work. The welding operator merely strikes an arc, pulls a trigger to start the filler rod feeding, and steers the moving torch over the line of the weld.

According to the company, plain carbon steels and stainless steels in the thickness range from 0.020 in. to 0.125 in. can be welded with excellent results.



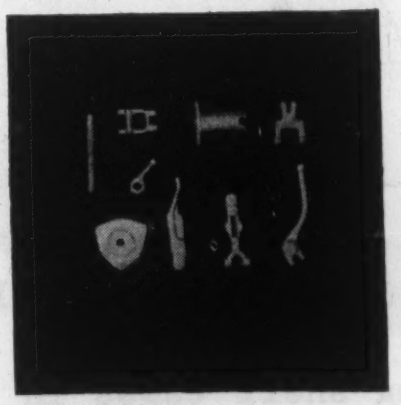
Accumet Precision Castings

for all industrial uses

With Accumet Precision Castings, Crucible has developed a process of producing precision investment castings in intricate designs with the smooth, satiny finish and closely-held dimensions characteristic of "lost wax" castings. Casting tolerances start at plus or minus 0.005" although under certain circumstances closer tolerances can be held. This relatively new metal forming process solves many difficult problems in design, tooling and production of metal components.

fuel injectors from precision castings

Fuel injectors and carburetors for aircraft are mechanisms containing a variety of peculiarly shaped component parts. The usual procedure is to use hardenable, chrome stainless steels, Types 416 and 440F, which are most adaptable to easy machining. However, to save costs in machining from bars, stocks and forgings, Crucible applied Accumet Precision Castings. The close size control and good surface finish of the castings eliminate many costly machining operations — saving manpower, machine time and tooling expense.



more information available on castings

Long a leader in the development of precision investment castings, Crucible offers you the services of an alert metallurgical staff to help you profitably apply these specialty steels to your operation. Write us for more detailed information. CRUCIBLE STEEL COMPANY OF AMERICA, General Sales and Operating Offices, Oliver Building, P. O. Box 88, Pittsburgh 30, Pennsylvania.

CRUCIBLE first name in special purpose steels

52 *years of Fine steelmaking* **PRECISION CASTINGS**

REX HIGH SPEED • TOOL • STAINLESS • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

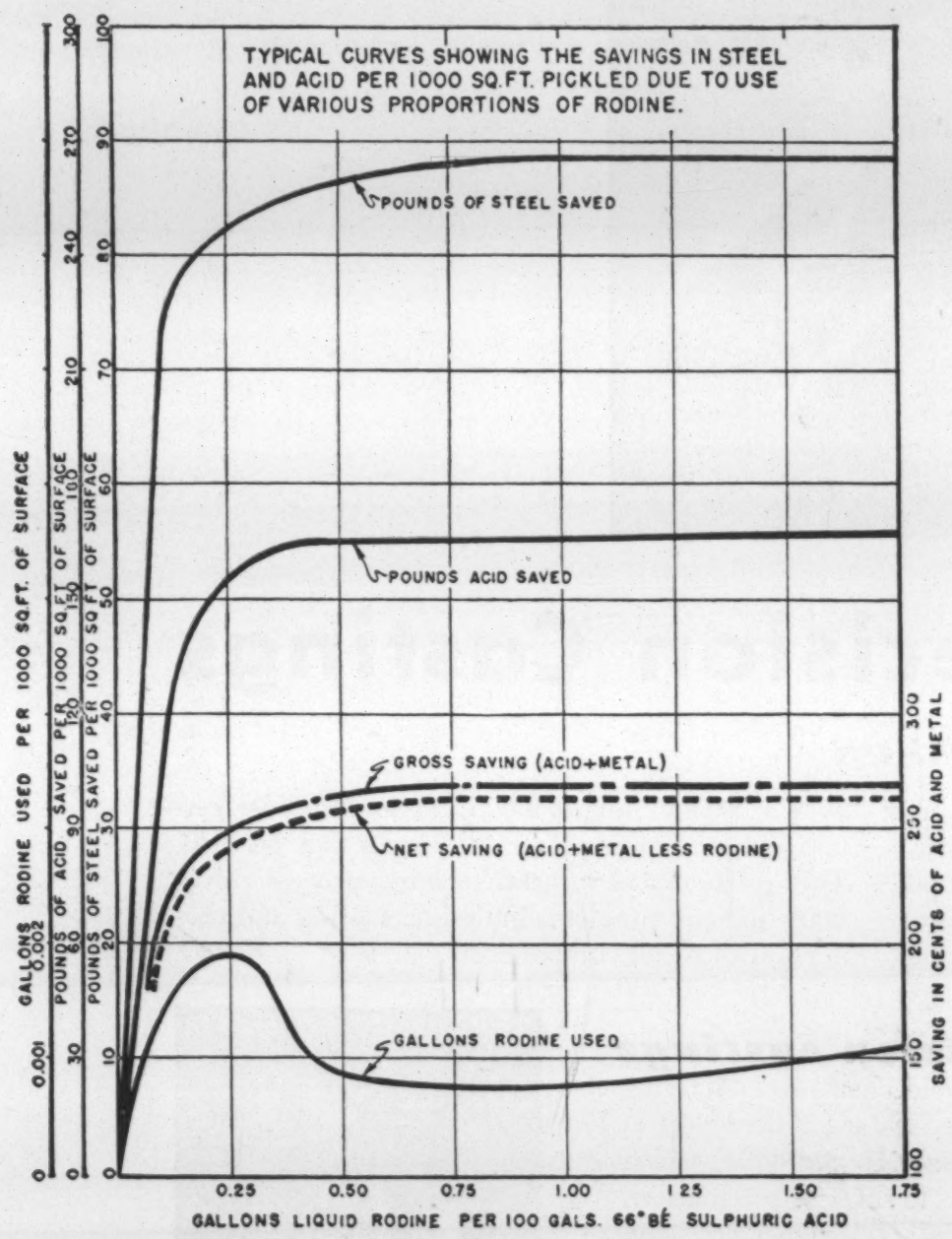
AMERICAN CHEMICAL PAINT COMPANY

AMBLER CHEMICALS ACP PROCESSES PENNA.

Technical Service Data Sheet

Subject: EFFICIENT PICKLING WITH "RODINE"®

A. SAVINGS POSSIBLE WITH "RODINE"



B. TYPICAL APPLICATION OF "RODINE"

Pickling shell cases in uninhibited muriatic or sulfuric acid contributes to their embrittlement and makes it difficult to draw them without breakage. By adding a small amount of "Rodine" to the pickle bath, embrittlement is suppressed and more than enough acid is saved to pay the costs of the inhibitor.

CHEMICALS ACP PROCESSES WRITE FOR DESCRIPTIVE FOLDER ON "RODINE" AND INFORMATION ON YOUR OWN PICKLING PROBLEM. CHEMICALS ACP PROCESSES

A Letter to the Editor

To the Editor:

We should like to call to the attention of the readers of MATERIALS & METHODS that the title of the article, "Electrodeposited Tin Alloy Coatings Are Promising Alternates for Tin Plate", which appeared in the December 1951 issue, is misleading. The article illustrates very clearly that the tin-copper, tin-zinc and tin-nickel electrodeposits may serve as alternates for metals now in short supply, but not for tinplate.

The tin-alloy coatings should not be considered as alternates for tinplate since tinplate is almost exclusively associated with the container industry and the processing of foods. The "tin can", as we know it, is fabricated from steel coated with pure tin and provides a non-toxic coating for which no alternate appears imminent.

We hasten to add that the article itself points out that the tin alloy coatings will be most useful as a replacement for cadmium and zinc coatings, and as an alternate for the nickel-chromium finish.

R. M. MacIntosh
Supervisor, Chemical Development

Tin Research Institute, Inc.
Columbus 1, Ohio

Reprints Available

It is still possible to obtain reprints of most of the "Materials & Methods Manuals", which cover materials, fabricated parts and processes. Reprints may be obtained at a cost of only 25¢ per copy. Turn to page 249 for a list of the available Manuals and the handy coupon for sending in your order.

NICKEL-CHROMIUM MOLYBDENUM STEEL VALVE CASTING

Retains Stamina after 50,000 Hours at 900° F!

After exposure to steam at 900° F. for more than 6 years, a Lunkenheimer gate valve cast in nickel-chromium-molybdenum steel was made available for study through cooperation of The Detroit Edison Company.

Despite its long continuous service, examination of specimens taken at random, including sections of welds, revealed the following characteristics:

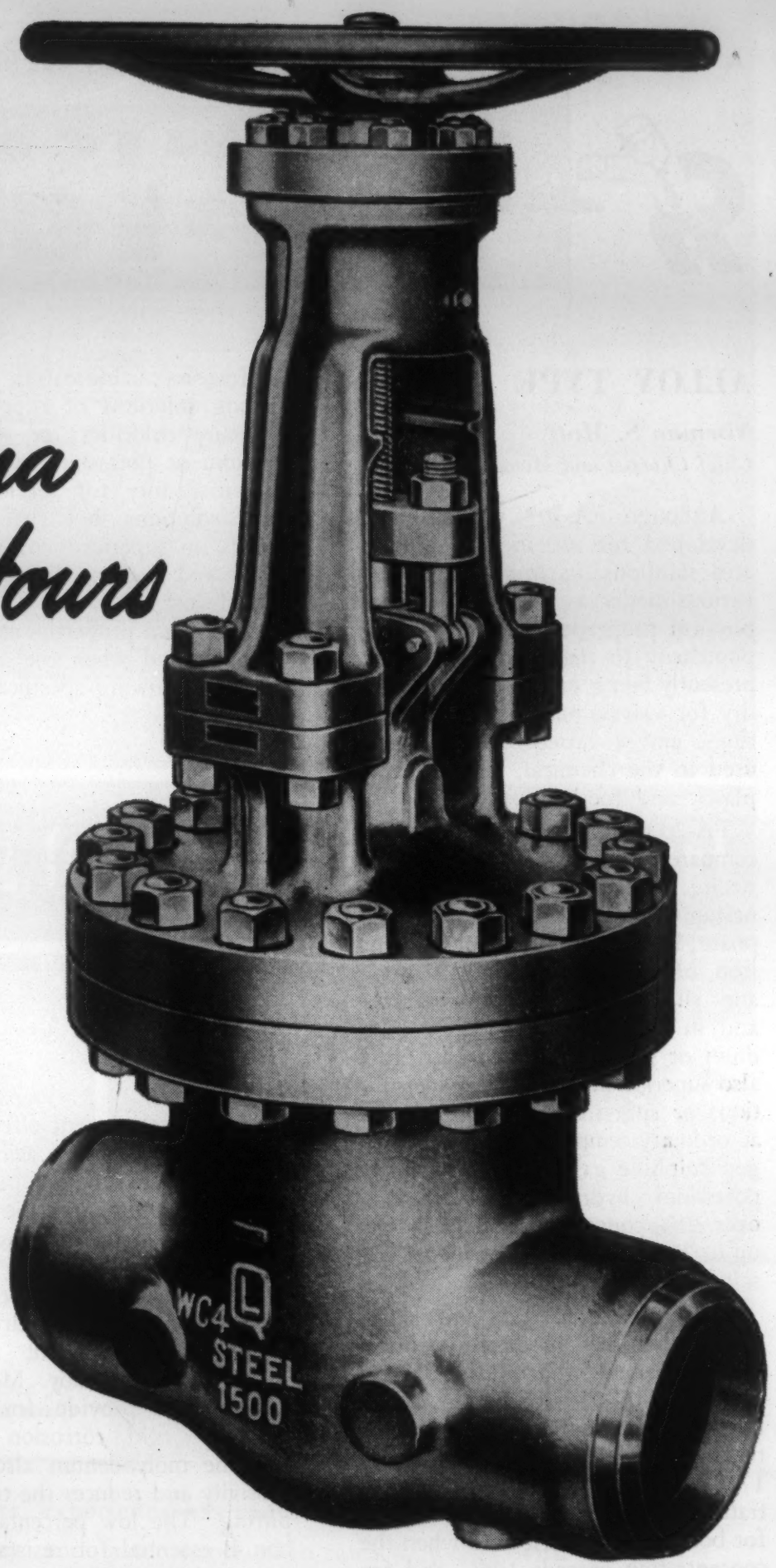
NO LOSS OF STRENGTH

NO EMBRITTLEMENT

NO OCCURRENCE OF GRAPHITE

This confirms extensive laboratory tests and provides convincing evidence that valves and fittings cast in nickel-chromium-molybdenum steel, conforming to requirements of grade WC-4, ASTM Specifications A-217, will adequately meet the severe conditions imposed by steam at high pressures and temperatures up to 900° F.

At present time, the bulk of the nickel produced is being diverted to defense. Through application to appropriate authorities, nickel is obtainable for the production of engineering alloy steels for many end uses in defense and defense supporting industries.



MANUFACTURED BY THE LUNKENHEIMER COMPANY, Cincinnati 14, Ohio, the valve selected for test was identical to the 4-in. gate valve shown above. Before removal for study, it served continuously for 53,810 hrs. at a nominal temperature of 900° F. and at an average pressure of 841 p.s.i.

EMBLEM OF INCO SERVICE

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

A regular service of The **COOPER ALLOY** Foundry Co., Hillside, N. J.

TECHNICAL TOPICS

ALLOY TYPE FA-20*

Norman S. Mott
Chief Chemist and Metallurgist

Although FA-20* was originally developed for use in hot sulphuric acid solutions, its high resistance in various media, as well as its superior physical properties, has increased its popularity to the point where it is presently being supplied by our foundry for valves, pump units, pipe fittings, and a variety of cast shapes used in the chemical, textile, paper, plastic and food industries.

FA-20 offers superior resistance, as compared with 18-8-SMO, in hot strong solutions of calcium or magnesium chlorides and aluminum sulphate; in dilute solutions of tin, zinc, iron or mercury chlorides at room and slightly elevated temperatures; and in cold dilute solutions of sodium or calcium hypochlorite. It is also superior in sulphur dioxide solutions or sprays, in dry chlorine gas at ordinary temperatures, wet hydrogen sulphide gas, boiling sodium or potassium hydroxide solutions of over 30% concentration, acid sludges up to 200°F., and in hot vinegar and salt solutions.

In sulphuric acid its use is required when the concentration is over 40% at room temperature, 10% at 175°F. or 0.75% at boiling; and it is satisfactory in all concentrations of this acid at temperatures up to 175°F., and up to 40% of concentration at boiling. It is recommended for boiling phosphoric acid when the concentration exceeds 10%, and for hydrofluoric acid of less than 10% or over 60% strength at room temperatures, although fair service may be had at all concentrations.

FA-20 is not recommended for use with wet chlorine gas or other wet halogens; chloroacetic acid; hot strong solutions of copper, iron or mercury chlorides; or with molten sodium or potassium hydroxides. It is satisfactory for service in nitric acid solutions, but for this use it offers no superiority over 18-8 type alloy and does not justify the additional cost.

Maximum properties at lowest cost are achieved when the alloy is cast to the following specifications:

Carbon	.07% Max
Chromium	20.00%
Nickel	29.00%
Copper	4.00%
Molybdenum	3.50%
Silicon	1.00%
Manganese	1.00%
Tensile Strength	75,000 psi
Yield Point	45,000 psi
Elongation 2″	40%
Reduction in Area	45%
Brinell	150

The nickel content offers good resistance to sulphuric acid corrosion and maintains the copper in alloy solution, minimizing the possibility of its becoming a contaminant in corrosion. Chromium provides resistance to nitric acid and other oxidizing media, and together with the nickel supplies the excellent mechanical properties of the alloy. Molybdenum and copper provide for increased sulphuric acid corrosion resistance and the molybdenum also increases passivity and reduces the tendency to pitting. The low percentage of carbon is essential for resistance to intergranular corrosion attack. Silicon and manganese are incidental to the production of the alloy, and in the amounts present provide little influence on mechanical or corrosion resisting properties.

* Produced under Durimet patents.

Copies of this article reprinted on heavy stock for convenient filing are available on request.

The **COOPER ALLOY** Foundry Co., Hillside, N.J.

New Interleaving Paper for Aluminum Inhibits Water Stain

by **W. Y. BLEAKLEY** and **C. C. LACY**,

Div. of Metallurgical Research,

Kaiser Aluminum & Chemical Corp.

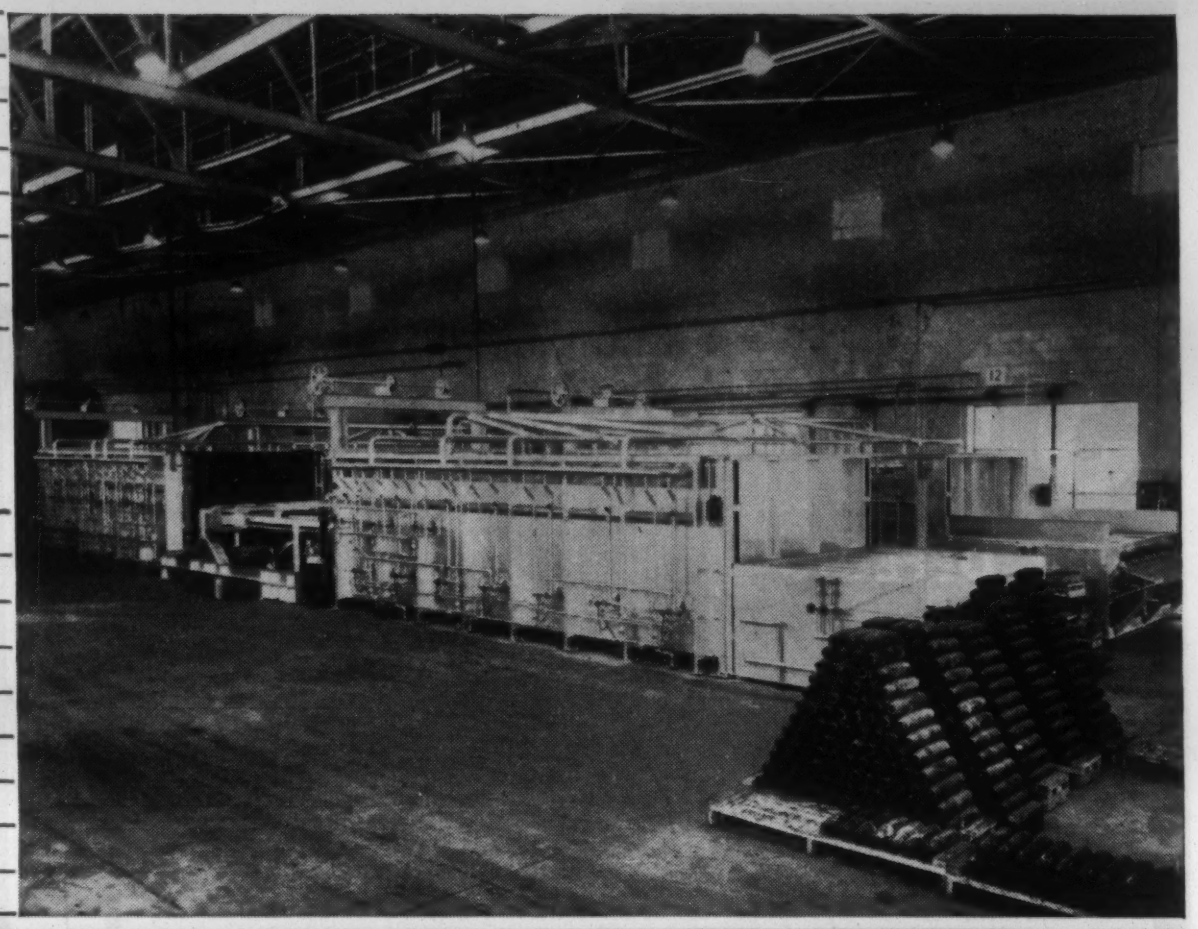
● INTERLEAVING TISSUES have long been in common use in the metal industries for cushioning flat sheet against vibration abrasion, which occurs during shipment. Recently completed investigations have established a technique that also uses these tissues to prevent water stains of aluminum in stacks of flat sheet. The technique simply calls for the impregnation of the tissues with certain corrosion inhibitor compounds.

Water staining does not affect the physical properties of aluminum, but it does mar the appearance of finished sheet products. In most cases this phenomenon, encountered with most metals and many nonmetals, is initiated by sharp, sudden changes in temperature in humid atmospheres. However, it may also be caused by accidental heavy wetting of a package or stack of flat sheet material during unloading or warehouse handling.

In normal service, water stains do not develop on aluminum because their formation depends upon certain conditions. There must be a limited supply of air, a small amount of moisture, and the restriction and weight pressure which exist in stacks of flat sheet or nested forms before water stain will occur. The moisture which condenses on cool metal from warm humid air is drawn between the sheets of a stack by capillary action. In the minute crevices between pieces, water stains assume mirror symmetry on the parting surfaces of the metal sheets.

Several packaging methods have been developed for combating water staining of aluminum. Most notable

(Continued on page 178)



Loftus heat treat line for treating shell cases provides completely automatic operation from loading conveyor to unloading conveyor.

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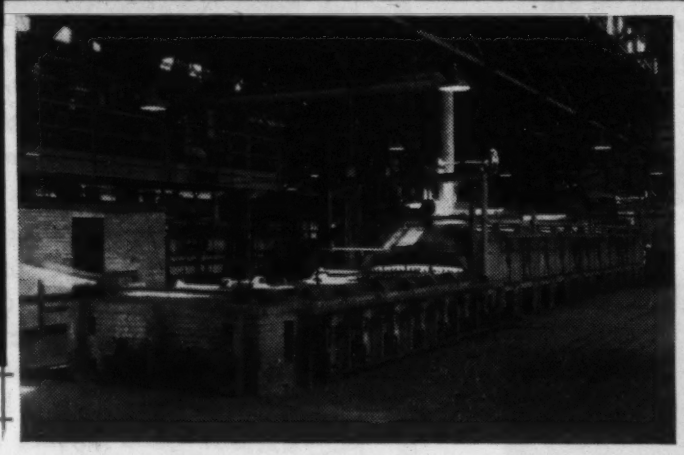
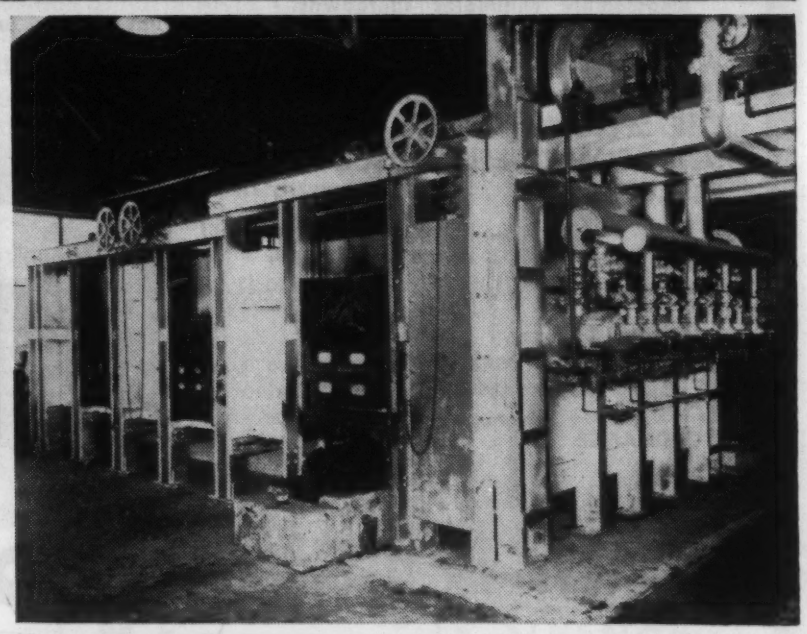


Production rate increases of 50% have been achieved through installation of this Loftus strand furnace.



Loftus automatic continuous furnace for forging and heating produces loose, easily removed scale.

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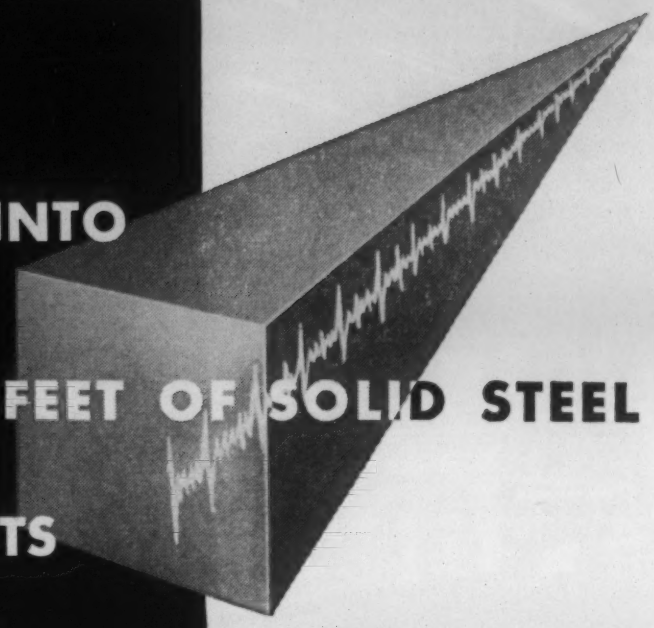

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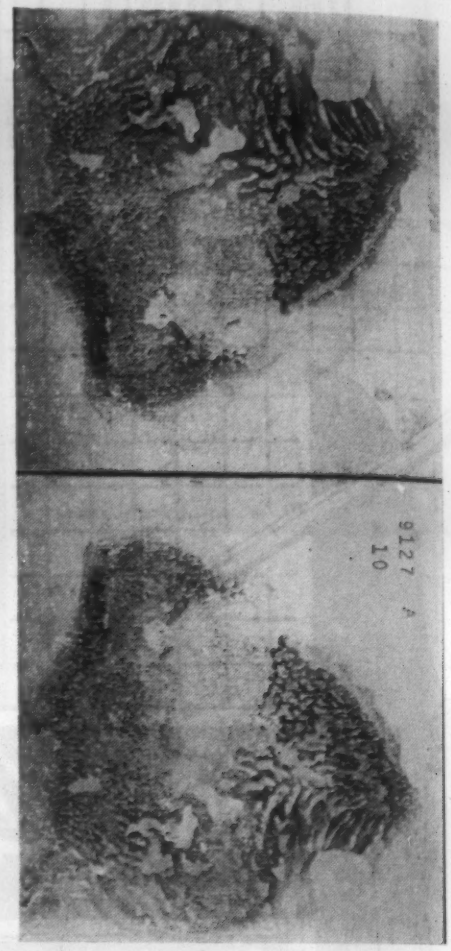
New Interleaving Paper. . . .

continued from page 176



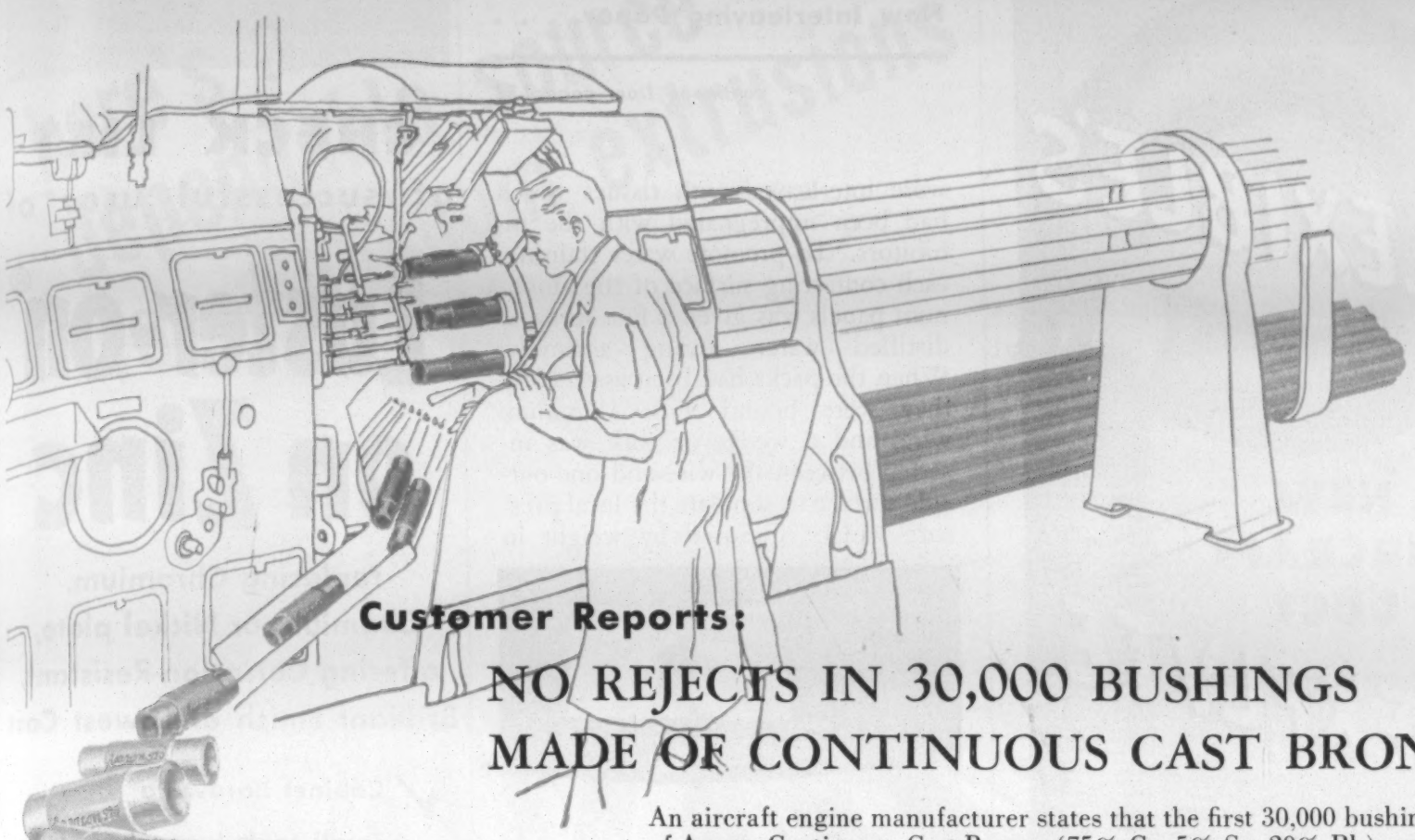
Contacting surfaces of two flat panels used in the study of water staining of aluminum during shipment and storage. Note mirror symmetry of stains.

of these has been the addition of petroleum-base inhibitors to the light engine oils which are sometimes used to coat the surfaces of flat sheet against abrasion. However, these inhibited oils are frequently objectionable to fabricators who have no need for a lubricated surface in their production schedules and who do not want the added operation required for removing the oils. Many such fabricators specify unoiled sheet when they place an order with an aluminum producer. In shipments to these fabricators, interleaving tissues are used to act as cushions between the flat sheet surfaces. Unfortunately, ordinary interleaving tissues offer very little or no protection against the water staining which occurs after the material has been warehoused.

Using the tissue as the carrier for chemical compounds which have shown corrosion inhibting qualities in various applications, investigations were begun in the Kaiser research laboratories several years ago to find an inhibitor that would eliminate the problem of water stain for consumers of aircraft quality sheet.

In these investigations, test packs of at least five flat aluminum sheets

(Continued on page 180)



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NO REJECTS IN 30,000 BUSHINGS MADE OF CONTINUOUS CAST BRONZE!

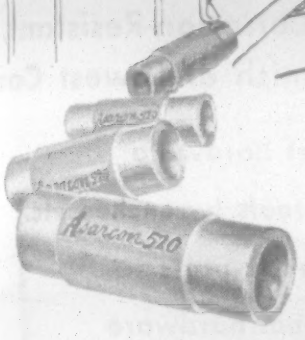
An aircraft engine manufacturer states that the first 30,000 bushings made of Asarco Continuous Cast Bronze (75% Cu, 5% Sn, 20% Pb) were tested with black light. There were NO REJECTS! Inspection by this means was discontinued as no longer necessary.

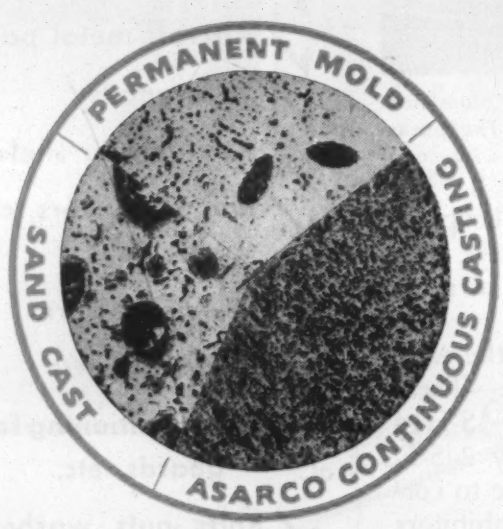
Asarco Continuous Cast rods, tubes and shapes offer production economies which are unique. Porosity is virtually non-existent. No sand, dirt or other foreign matter is used in the casting process, so that there are no inclusions to harm tools. Cutting speeds can be high, too. All stock for machining is held to close tolerances and is Medart straightened. Tube concentricities are within 1.5% of wall thickness. Continuous Cast Bronzes are ideal for use on automatic screw machines.

You can get Continuous Cast Bronzes made to order in a wide variety of alloys . . . in standard lengths of 12′ . . . lengths 5′ to 12′ on request . . . lengths 12′ to 20′ on special arrangement.

216 sizes of the standard Asarcon 773 bronze (SAE 660) are stocked in 105″ lengths for convenience at warehouses in principal cities across the country. Distributors will cut the warehouse stock *long or short* to suit your specific requirements.

Send for a free catalog on Asarco Continuous Cast Bronzes. It contains physical properties, photomicrographs, table of stock shapes and sizes, weights and other valuable information.





75% Cu
5% Sn
20% Pb

POROSITY VIRTUALLY ELIMINATED WITH CONTINUOUS CAST BRONZES

Note in these photomicrographs the superior dispersion of constituents in the continuous cast alloy . . . also its outstanding freedom from metal faults.

COMPARISON OF TYPICAL TENSILE STRENGTHS

85-5-5-5 ALLOY

Sand Cast	36,400 psi
Permanent Mold	41,200 psi
CONTINUOUS CAST	45,000 psi

83-7-7-3 ALLOY

Sand Cast	40,400 psi
Permanent Mold	41,600 psi
CONTINUOUS CAST	44,000 psi

In addition to the tensile strength superiority shown above, Asarco Continuous Cast Bronzes have up to 100% higher fatigue characteristics . . . impact strengths increased from 15% to double those of the same alloys cast by other means . . . substantially improved yield strengths, elongation values and hardnesses.

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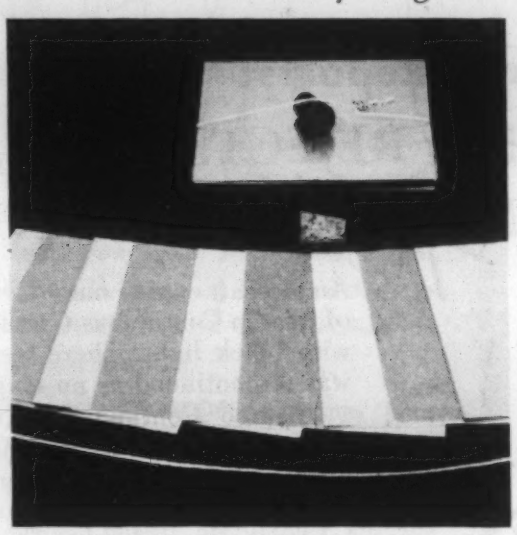
New Interleaving Paper. . . .

continued from page 178

were interleaved with tissues which had been impregnated with the inhibitors. To promote water staining, each contacting surface of the aluminum panels was given a fine spray of distilled water during assembly. When the packs had been assembled, they were bound with aluminum wire, and a wedge or cork was inserted between the wire and one outside surface to simulate the local pressure which is caused by weight in



Test packs contained at least five aluminum panels interleaved with tissues. The packs were bound with aluminum wire and wedged with a cork.

stacks of sheet materials. The packs were then stored for 30 days over water which was maintained at room temperature.

Two alloys were used in the early stages of the investigation. These were the commercial alloy 3S-H14 and the noncommercial alloy 24S-F, which is especially vulnerable to corrosion. When effective inhibitors were found, the tests were expanded to include other aluminum alloys.

In this investigation, sodium chromate was found to be the most effective and commercially feasible chemical compound for the prevention of water stains in stacks of flat sheet. A range of 1.5 to 3% of sodium chromate, based on the dry weight of the treated paper, was found to give good protection against water staining.

In the near future, this impregnated tissue should be available for the protection of stored aircraft alloys. Several tissue manufacturers are already beginning production. The use of sodium chromate impregnated interleaving tissues may eventually solve the problem of water staining in flat sheet stacks of many materials other than aluminum. The entire development is protected by the patent rights of Kaiser Aluminum and Chemical Corp.

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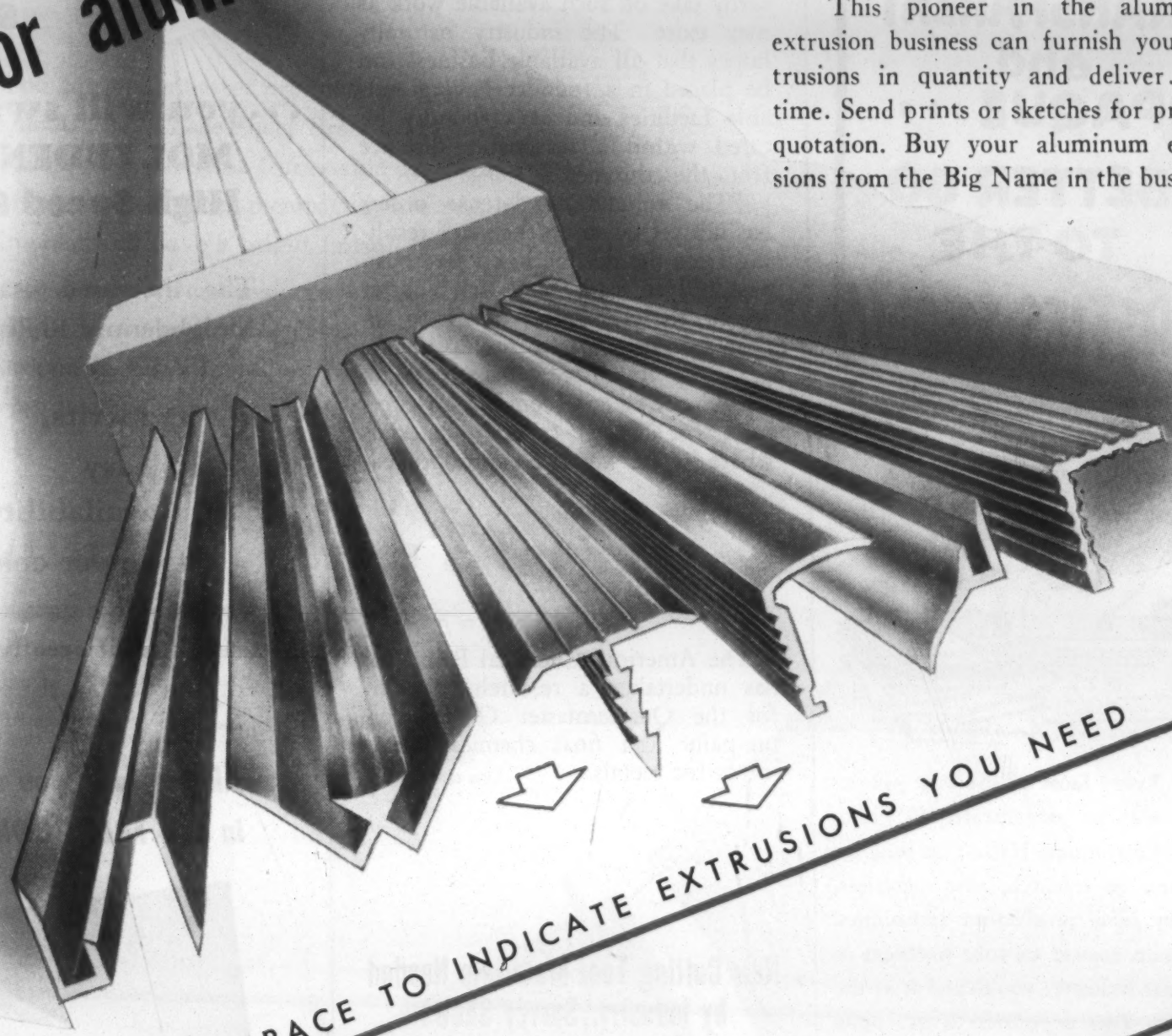

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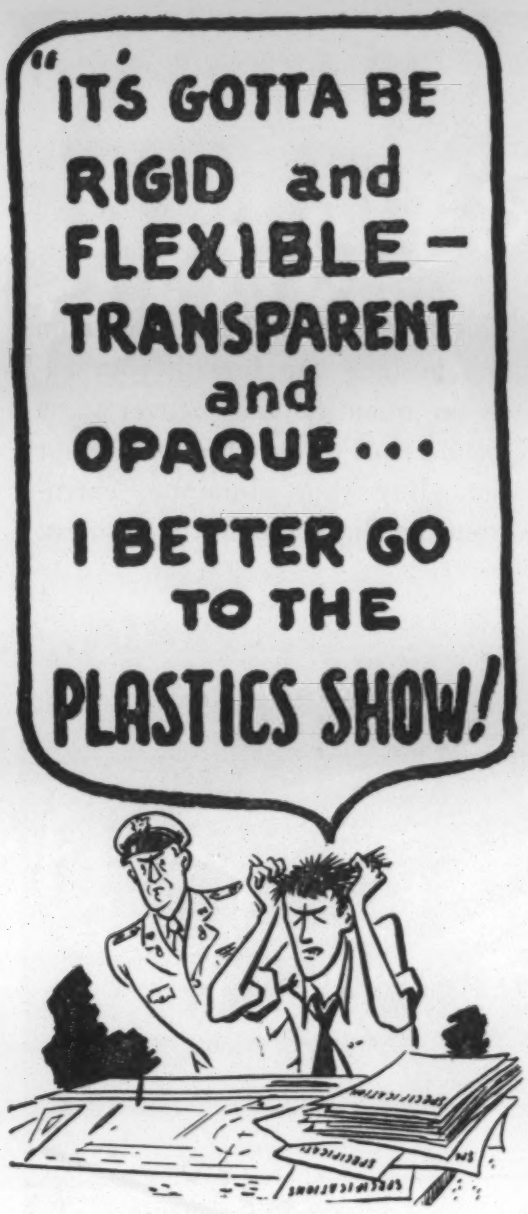

Every facet of the vast plastics industry will be concentrated in Philadelphia's Convention Hall. You will see what's *new* in research, raw materials, machinery, and production techniques. If there's an answer to your problem in the plastics industry, you'll find it at the Exposition. *This exposition is not open to the public. Requests for admission tickets should be written on your company letterhead directed to* THE SOCIETY OF THE PLASTICS INDUSTRY, Inc., 67 W. 44th Street, New York 18, N.Y.

1952 NATIONAL PLASTICS EXPOSITION

PHILADELPHIA CONVENTION HALL

MARCH 11 - 14, 1952

News Digest

continued from page 13

sarily take on such available work as may exist. The industry naturally hopes that all available business can be placed in a foundry having suitable facilities and at a foundry located within a reasonable distance from the customer."

"The volume of defense orders has not yet taken up the slack resulting from the decline in civilian business," Ryan said, "and the industry would, therefore, not want it to appear that no capacity was available, or, more important, that malleable should not be considered as an alternate for other critical materials where its use would be appropriate."

● The American Chemical Paint Co. has undertaken a research program for the Quartermaster General on pre-paint and final chemical treatments for metals.

New Cutting Tool Materials Needed by Industry, Survey Shows

Detroit—Present day cutting tools are not standing up under the loads imposed by machining jet engine alloys and other related hard, tough materials from which military equipment is being made, results of a nation-wide survey of industry revealed here. The survey was made by the American Society of Tool Engineers.

According to Harry E. Conrad, Executive Secretary of the Society, 27% of the companies want cutting tools with longer life. "This indicates," Conrad pointed out, "that present-day cutting tool materials are wearing out too fast under the strains of machining harder and tougher parts. Of those queried, 19% asked specifically for tougher, harder tool materials that will cut modern metals more efficiently."

Conrad explained that the survey results show that better cutting tool materials are a must in our security production program. "The age of

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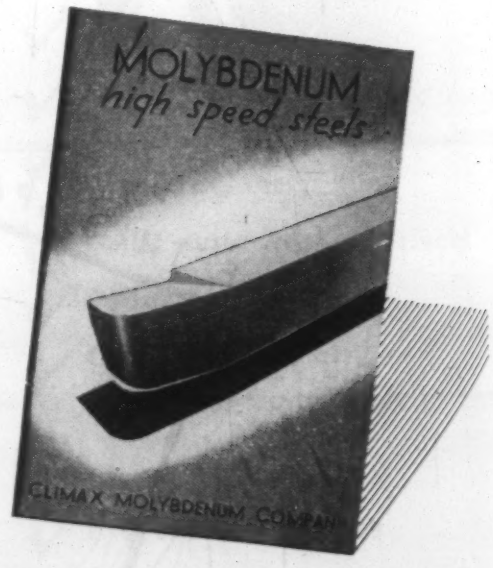

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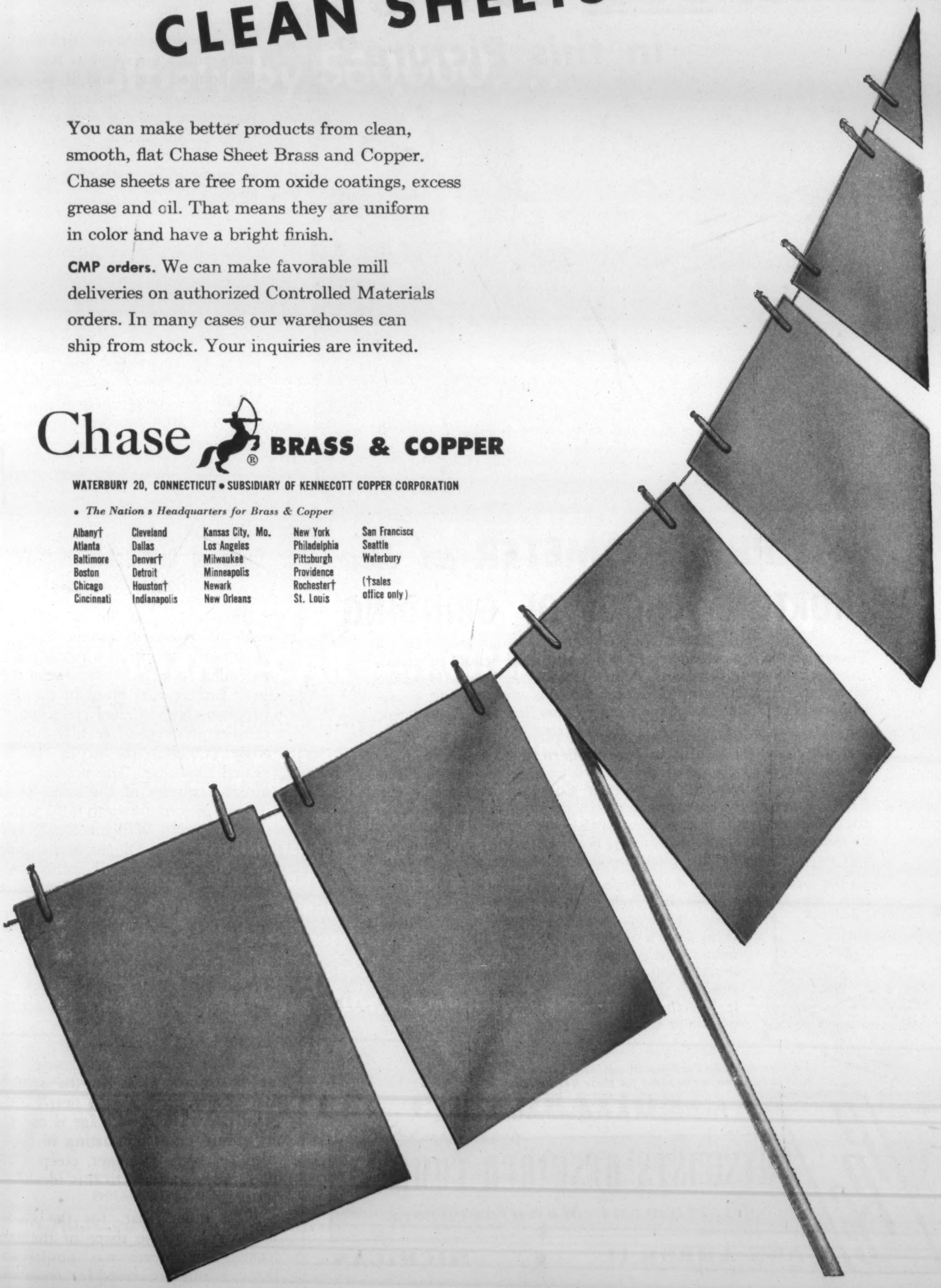

MEASURE IN MICROINCHES RMS

What Does Belong— *in this Picture?*

...*the* PROFILOMETER *at the* NORTON SCHOOL OF GRINDING

Shown above is a customer group attending the school of grinding of the Norton Company, Worcester, Massachusetts. Here the latest grinding machine developments are explained to representatives of a number of the country's leading industrial firms.

One piece of equipment appears in this picture . . . the Profilometer. Obviously, in a discussion of modern grinding techniques, an accurate knowledge of the surface finishes that are secured is of primary importance. Norton Company recognizes the Profilometer as the instrument which does provide dependable roughness ratings in microinches RMS—the accepted standard of measurement throughout industry. For that reason, the Profilometer *does* belong in this picture—and on this conference table.

To the men who attend these sessions, the value of the Profilometer increases immeasurably when they put it to everyday use in the production departments of their own plants. There it becomes a part of routine grinding and other machining procedure . . . a means to secure exactly, quickly and easily the information desired on surface finishes. That is why you find it "in the picture" in their companies and wherever quality control is a consideration.

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specialized metals for high temperatures and high speed is here now," he pointed out, "and if we are to produce superior military equipment from these harder, stronger, temperature-resistant metals, we will have to develop tools or techniques that maintain high machine productivity levels."

● The steel industry is expected to raise its annual basic productive capacity by 10,500,000 tons in 1952, to 117,500,000 tons, according to Walter S. Tower, president of the American Iron and Steel Institute.

Creep of Cold-Drawn High-Purity Copper Studied

Investigation at the National Bureau of Standards of the creep of high-purity copper has recently been extended to include cold-drawn copper. In an earlier phase of the same program, NBS studied creep characteristics of oxygen-free high-conductivity (OFHC) copper in the annealed condition. The present work utilized samples of the same lot of copper, as cold-drawn to 40% reduction in area. William D. Jenkins and Thomas G. Digges of the NBS thermal metallurgy laboratory conducted the studies. Specimens were tested for their creep characteristics at 110, 250 and 300 F with constant loads in tension.

In general, creep—in terms of extension-versus-time under constant load—goes through three stages (after an initial extension that occurs on application of the load). The first stage is one of decreasing rate of extension. Then, in the second stage, creep proceeds at a nearly constant rate. The third stage is one of increasing rate, culminating in complete fracture. However, creep does not always conform to this idealized picture.

NBS found that, for the cold-drawn copper, the shape of the extension-time curves was similar to that previously observed for annealed

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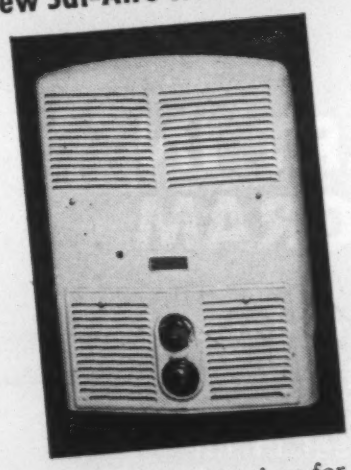

Quality finish specifications for this heating unit called for a coating that would stand 500° and still retain its color and gloss—a temperature far above that incurred in normal operation. Ordinary heat resistant coatings failed. SICON *Ivory* and SICON *Beige* worked perfectly...just as SICON has solved so many other finish problems. *Write for dynamic proof of SICON'S amazing stability under heat! New Brochure now ready.*

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copper, high-purity aluminum and ingot iron. Deformation in the second stage of creep was discontinuous, the degree of discontinuity being affected by test temperature and stress. However, no simple or consistent relation was found between the ductility of the cold-drawn copper and the time required to attain either the third stage of creep or complete fracture.

Curves showing the relation between stress and second-stage creep rate, for both the annealed and cold-drawn conditions, were not linear when the experimental results were plotted either on log-log or semi-log coordinates.

At each test temperature, the cold-drawn copper was markedly superior to the annealed copper in resistance to creep and to fracture. This superiority in strength, however, was accompanied by a considerable loss in elongation at fracture; for equivalent second-stage creep rates and temperatures, reduction of area at fracture was about the same for both forms of copper.

Metallographic study of the specimens after testing in creep confirmed the previous finding that several modes of deformation occur during the creep tests. For similar test conditions, the number and the size of the sub-crystals observed in the region of the fracture were decreased by cold-drawing the copper prior to testing in creep. Furthermore, cold-drawing the copper appeared to alter the condition under which transcrystalline and intercrystalline fractures occur; transcrystalline fractures predominate at higher temperatures and slower creep rates for the cold-drawn than for the annealed copper.

Cleaning of Magnesium Surfaces with Alkaline Detergents

The effect of alkaline detergents on a magnesium die casting alloy is the subject of a study by J. Fred Haxel and Wm. Stericker of the Philadelphia Quartz Co. The alloy used had the ASTM designation AZ91, and the cleaners employed were sodium hydroxide, trisodium phosphate, tetrasodium pyrophos-

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Promet XXX will not score, cut or powder even in lubrication failures. The coefficient of friction is considerably less than that of tin babbitts, thus reducing power loss and wear. The entire bearing surface wears uniformly, without pitting.

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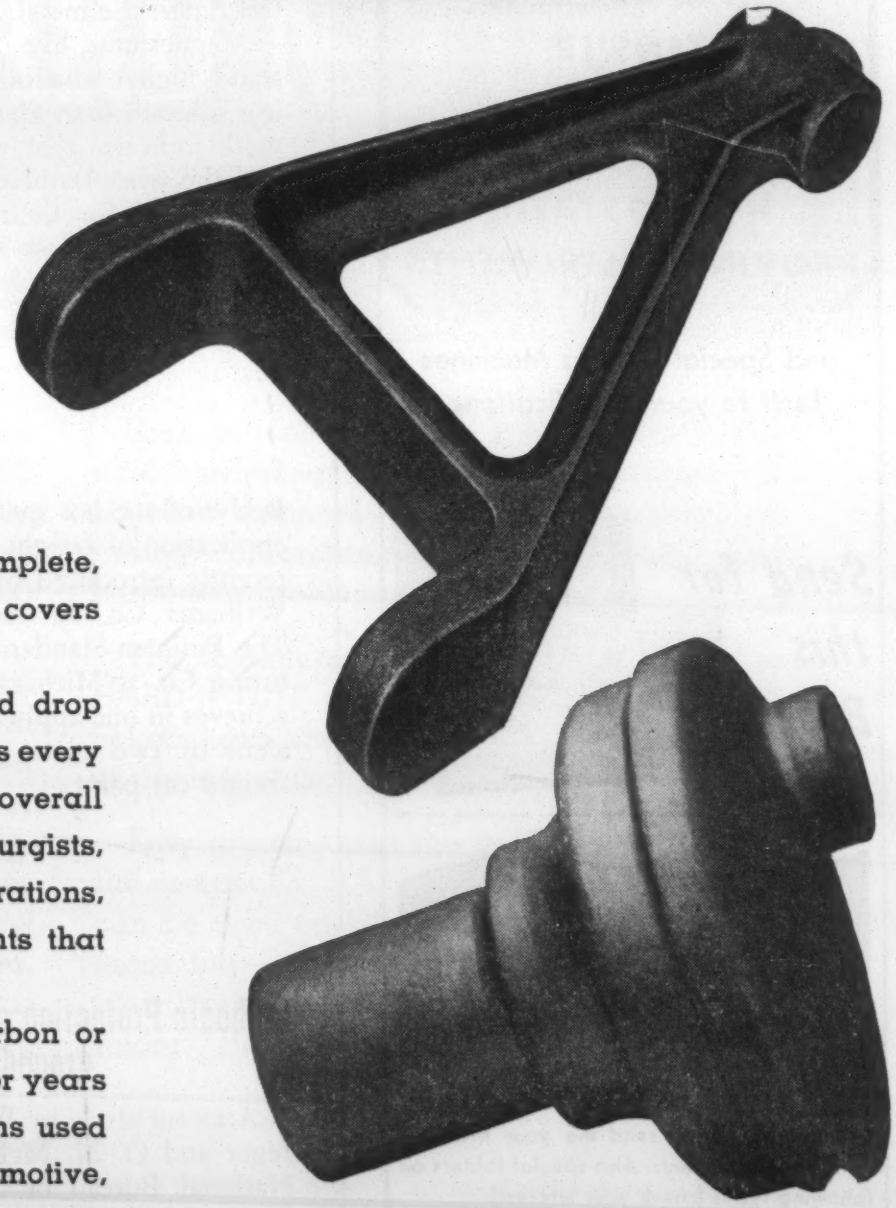

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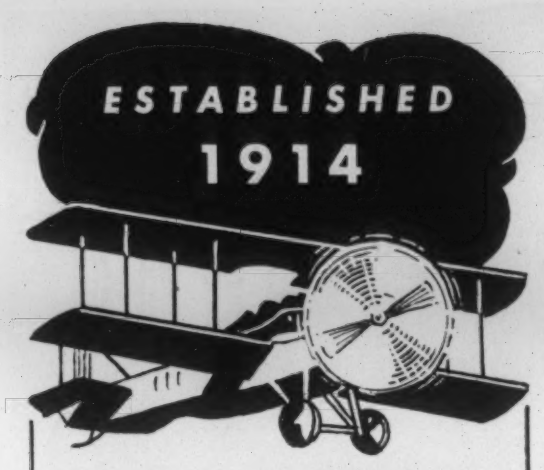

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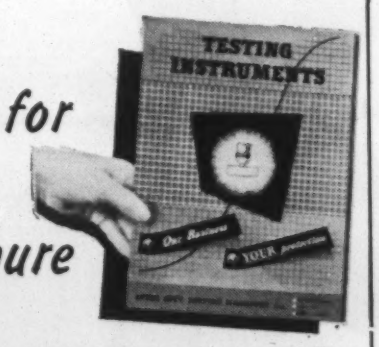

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News Digest

phate, Calgon, Quadrafos and several types of sodium silicate.

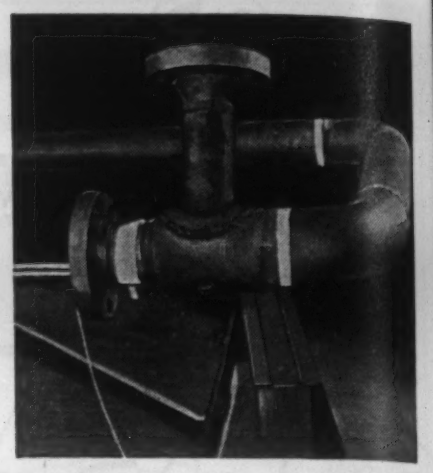
The interesting fact revealed by these tests was the indication that the complex phosphates commonly used as sequestering agents in cleaners had a detrimental effect on the magnesium alloy. When used both in a soak cleaner and in electrolytic cleaning (cathodic), the tetrapyrophosphate and other polyphosphates caused a discoloration of the alloy and marked loss of metal. Severe attack was experienced with all cleaners when the alloy was cleaned anodically (reverse current). The inclusion of proper amounts of sodium metasilicate (Metso Granular) with the tetrapyrophosphate eliminated all attack upon the metal.

Magnesium, like zinc, can withstand higher alkalinities in a cleaning solution than aluminum, but this work indicates that with magnesium and the pyrophosphates, the silicates are needed for their corrosion prevention ability just as they must be used in aluminum cleaners.

● Use of the hot spray system in the application of freight car finishes was recently introduced by The Sherwin-Williams Co. in cooperation with The Pullman-Standard Car Manufacturing Co. at Michigan City, Ind. It achieves in one application the equivalent of two coats of conventional freight car paint.

Cathodic Protection of Steel Underground

A recent study by W. J. Schwerdtfeger and O. N. McDorman of the National Bureau of Standards' corrosion laboratory provides a better understanding of the mechanism of the cathodic protection method of inhibiting underground corrosion. The NBS study centered around laboratory determination of the optimum potential to be maintained for effective protection. By eliminating uncertainties inherent in field measurements, NBS was able to determine



THIS PHOTO shows radium being used to take a radium-radiograph of a weld. Placing the radium centrally in the pipe and the film on the outside (held in place by white tape) permits radiographing the entire circumferential weld with one exposure.

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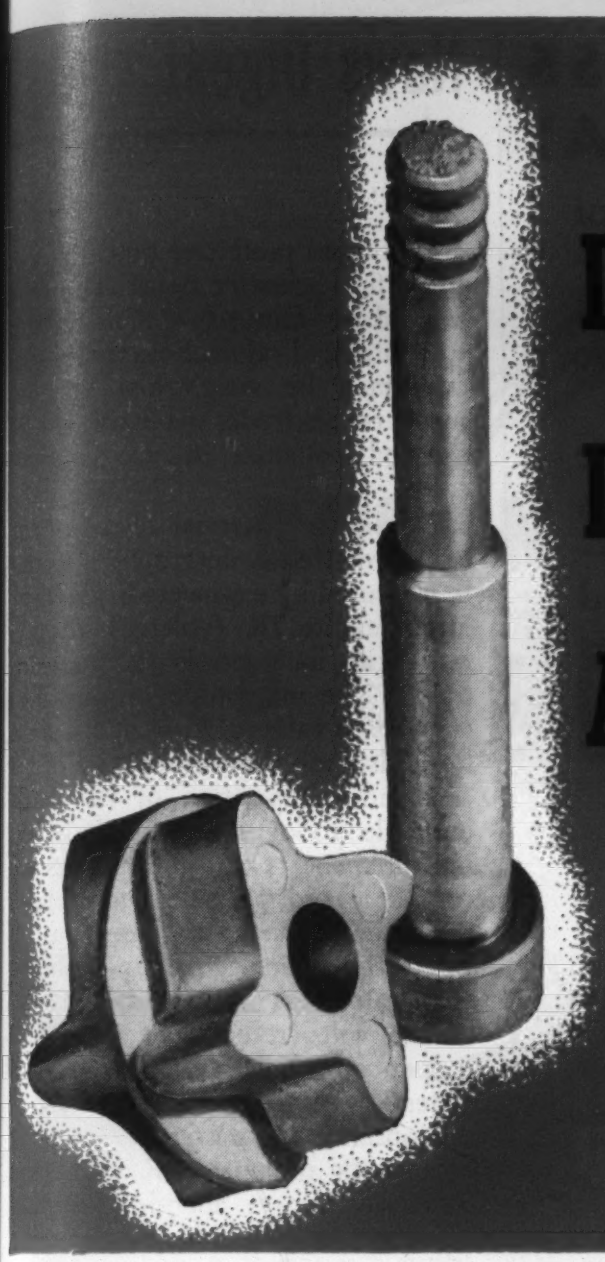

Life of This Tool Increased 17 TIMES After Treatment with HARD'N'TUFF

The die cast zinc rotor shown (left) is subjected to a burnishing operation which removes .02 inches of stock. The tool used (right) normally produced from high speed and hard chrome steels was able to finish only 20,000 to 30,000 pieces before refinishing.

Because of alloy steel shortages and in an attempt to bring about an efficient increase in production the tool was cut from cold rolled steel and treated with HARD'N'TUFF. The user says: "It finally wore out after 500,000 pieces. It held its size all the time it was in use. Previous tools of high speed and hard chrome plate steel lasted approximately 20,000 or 30,000 pieces. What better recommendation could I give your material?"

Here is real proof that HARD'N'TUFF, the steel hardening compound that provides fast effective three-way action;—carburizing, nitriding, chromizing—can solve many part hardening problems.

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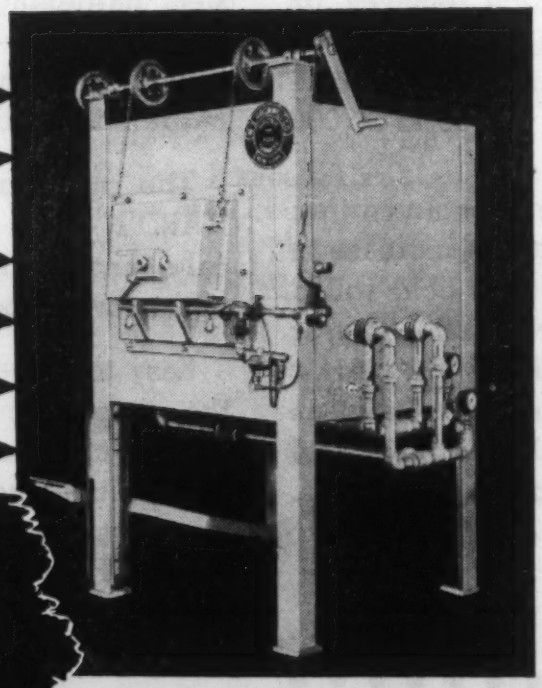

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an optimum protective potential having a firm scientific basis. The value arrived at—minus 0.77 volt referred to a saturated calomel electrode—was confirmed by weight-loss measurements on electrodes maintained at the selected potential in five corrosive soils.

When the potential of a cathodically protected underground structure is measured by engineers in the field, an indefinite IR (voltage) drop is ordinarily included in the measurement. The magnitude of this drop at a given value of current naturally depends upon the conductivity of the soil and the position of the reference electrode used in making the measurement. Corrosion circuits are complex, and there is no general agreement among engineers as to where the reference electrode should be located. A measured value of —0.85 volt (referred to a standard copper-copper sulfate electrode) is generally accepted by engineers as the optimum protective value. Yet because the amount of IR drop is not ordinarily known, identical readings of —0.85 volt obtained by engineers at different installations are not likely to indicate the protective potential free of undesired IR drop.

These uncertainties were eliminated in the NBS laboratory in arriving at the value of —0.77 volt referred to a saturated calomel electrode. Since this value corresponds approximately to —0.85 volt referred to the copper-copper sulfate electrode, the NBS work confirms the practice of cathodic-protection engineers for the special condition when all IR drop is eliminated except that which is included in the field of the normal corrosion circuits.

To arrive at the optimum protective potential for steel in soils, the potentials of steel electrodes were measured at NBS in 20 air-free soils, ranging from very acid (pH 2.9) to very alkaline (pH 9.6). Potentials were plotted against the pH values of the soils. The resulting curve intersected the potential curve for the standard hydrogen electrode at a pH of approximately 9 and a potential of —0.77 volt (referred to a saturated calomel electrode). This potential was also approximately the most negative value measured. At more negative potentials iron becomes cathodic to the hydrogen electrode and corrosion therefore ceases.

To confirm experimentally the ef-

for

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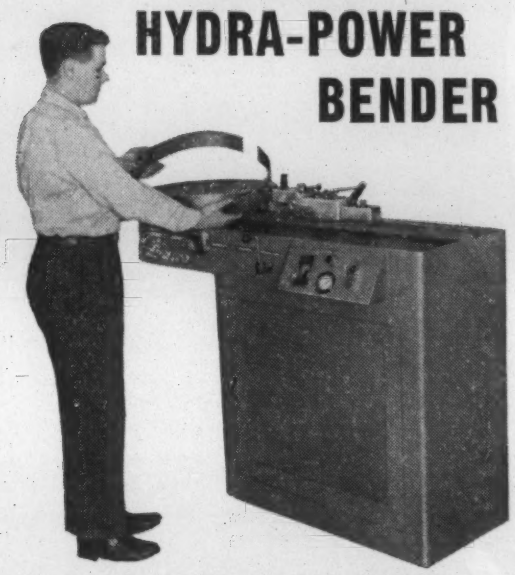

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fectiveness of a —0.77-v protective potential, weighed steel electrodes were exposed to five soils in specially designed corrosion cells. After two days without protective current, the electrodes were maintained at —0.77 volt for 60 days. By making potential measurements with an electronic interrupter in conjunction with a potentiometric measuring circuit, all IR drop external to the boundary of the corrosion circuit was eliminated. Weight lost during the test by the electrodes maintained at —0.77 volt was negligible compared with weight losses of control electrodes that received no current. Electrodes allowed to deviate for relatively short periods to potentials less negative than —0.77 volt, lost appreciable weight, but electrodes maintained at more negative potentials, (—1.0 volt) showed no appreciably greater reduction in weight loss.

The current required to maintain a —0.77 volt protective potential is not uniform. With most of the soils tested, the necessary current diminished to a fairly stable value after about three weeks. These minimum values of current needed to maintain the protective potential differed for different soils, and were approximately equal to the average corrosion currents calculated from the weight losses of the control (unprotected) electrodes.

It was possible to estimate the minimum protective current initially required for cathodic protection in a particular soil by preliminary measurements. Electrode potentials were measured as increasing values of current were applied. The potential-current curve given by these measurements has a characteristic change-in-slope at a certain current value, above which the potential changes more rapidly. The current indicated by the change-in-slope was taken to be the minimum value initially required for effective protection. This current, when constantly applied, caused the electrode potential to drift to the protective value (—0.77 volt) in from three to 21 days as alkali accumulated on the electrode surface.

Prior to disassembling the corrosion cells, the protected electrodes were left without protective current for about 15 hr, after which a curve relating potential to applied current was again obtained. This time the change-in-slope typical of corroding

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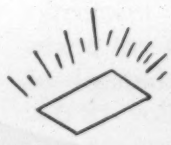

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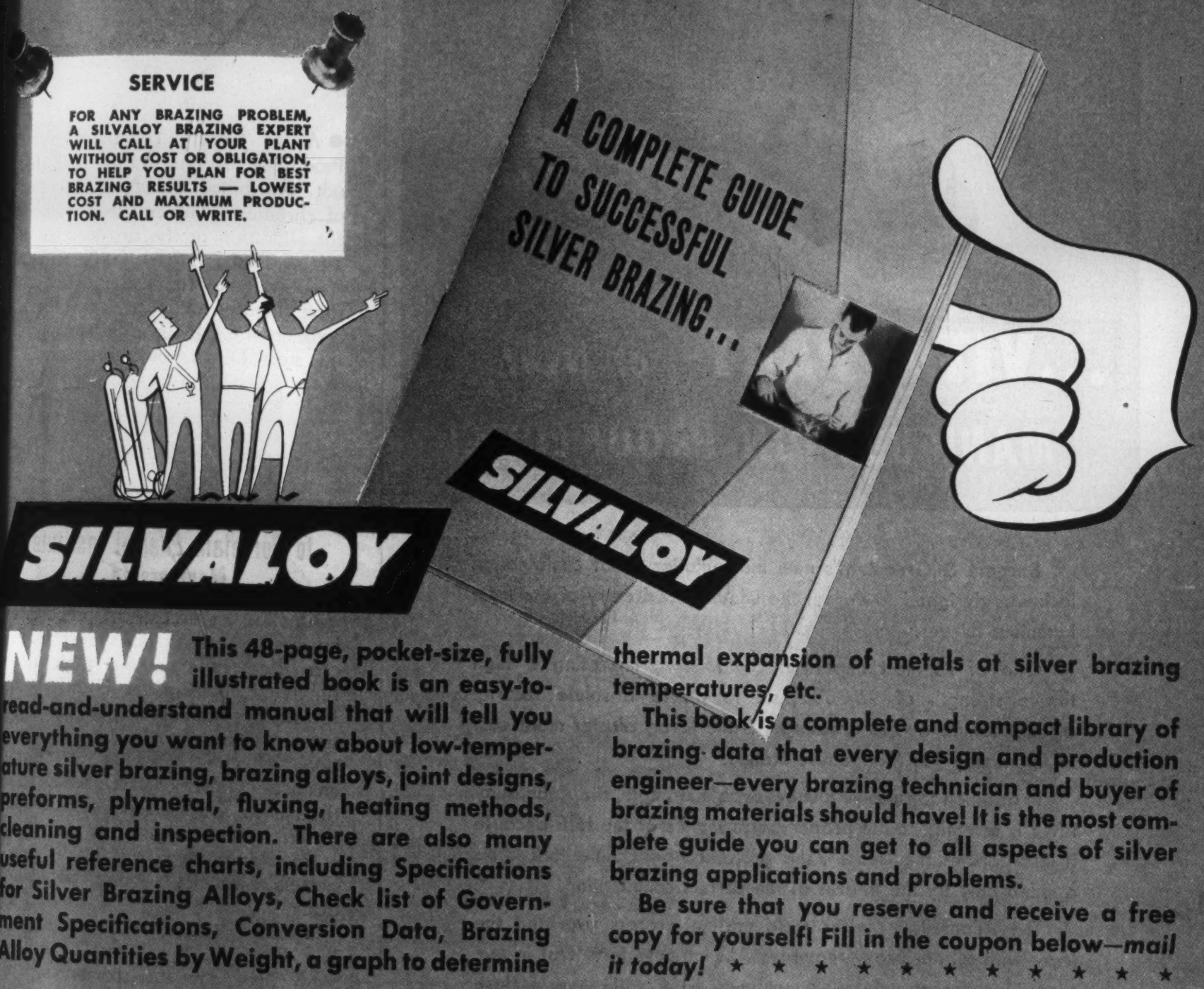

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One of its most important components, imparting a high tensile strength of 95,000 p.s.i. to assure absolute security against failure due to breakage, is the lever, plaster mold cast in Atlantalloy #31 Manganese Bronze.

In addition to supplying unbelievable strength, the Atlantalloy lever is essential to the proper performance of the lock because it incorporates the "fence". This projection permits the lock to be opened only by the bearer of the correct combination.

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News Digest

metals was no longer evident. This was taken as a further indication of the effectiveness of the protection against corrosion furnished by the —0.77-v protective potential.

● As of January 1st, the Defense Production Administration still has not distributed about 37,500 tons of chromium stainless steel available for allocation in the first quarter of 1952. This is 25% of all stainless steel available for use in the first three months of next year. Please come in and ask for an allocation of this steel, D.P.A. told fabricators.

Unusual Product Research Revealed to Porcelain Enamel Institute Membership

One of the most comprehensive business-provoking tasks ever to be carried out by a national association for its membership has recently been revealed by the Porcelain Enamel Institute. This national trade organization, which represents porcelain enameling firms of all kinds across the nation and their equipment and material suppliers, has just turned in a searching investigation of new porcelain enamel product possibilities.

Entitled "101 New Uses for Porcelain Enamel", the report of PEI's study brings to the membership a thumbnail analysis of the five most important considerations relative to the selection of a new product for marketing, and it covers, as a starter, exactly 101 new products having commercially feasible applications. These were compiled as an initial step by the New Uses Committee of the Institute, along with a number of other committees, and will be augmented later by additional reports as rapidly as they are completed.

The basis of the study was to select prospective new products and then submit each one to an investigation of the five principal marketing considerations for a potential producer. These were: (1) a complete

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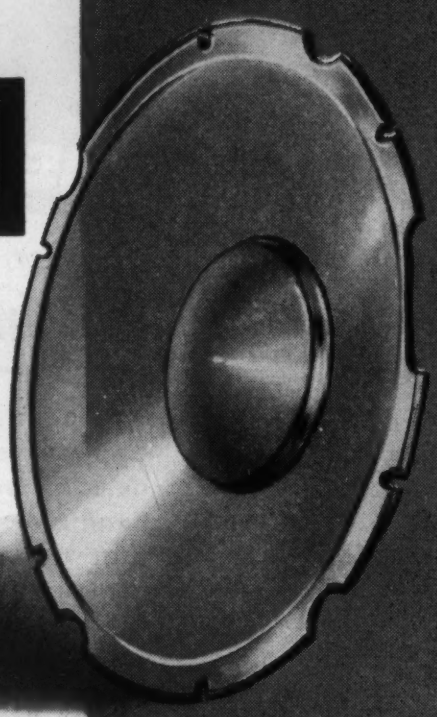

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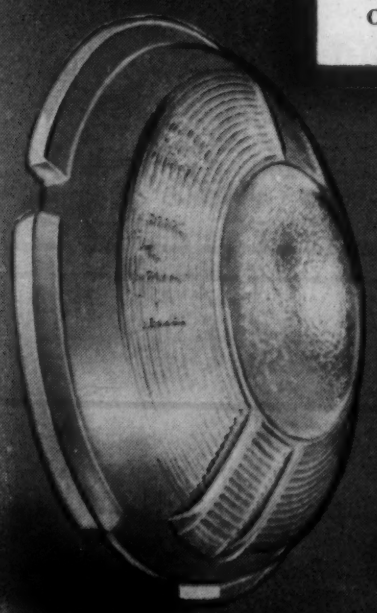

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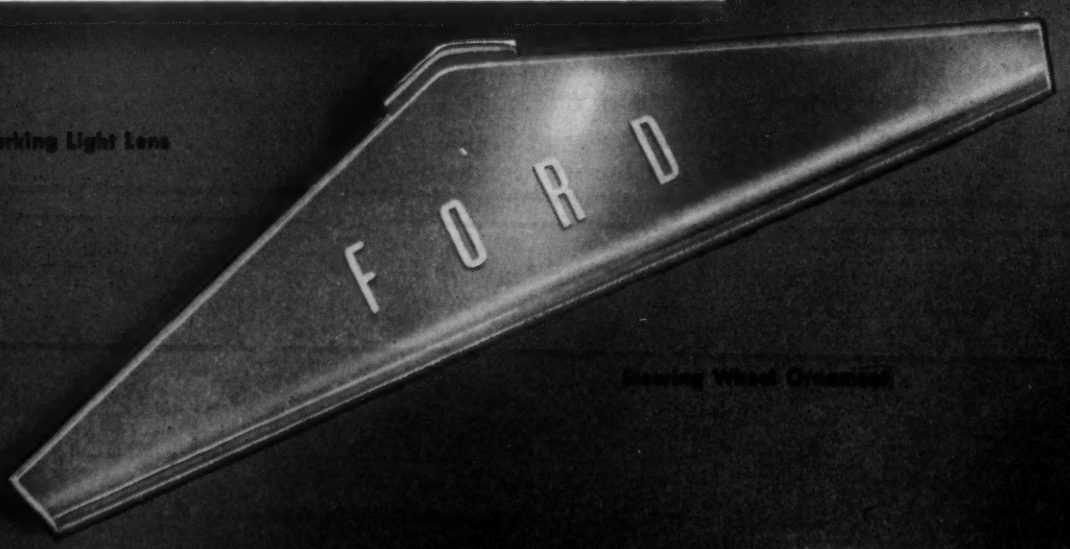

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Product of: Sunbeam Corp.
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Sunbeam, famous for quality electrical appliances, is a name symbolic of sound design and dependable performance. Example: this new Sunbeam Egg Cooker that turns out your morning egg exactly as you like it—day after day—regulated by Sunbeam's patented control actuated by Chace Thermostatic Bimetal. Minute man or hard-boiled customer, you'll enjoy eggs on the beam with Sunbeam.

The precision timing is based on the amount of water measured in the calibrated lid. Die-cast into the aluminum base is a 500-watt heating core "A" which cooks one to six eggs quickly and evenly. When the water evaporates, the sudden rise in ambient temperature causes the thermostatic bimetal element "B" to deflect away from the high responsive side. The flexibility of the linkage "C" permits considerable deflection of the element and a gradual increase in power which finally forces the spring loaded signal arm "D" past dead center. Result is a snap opening of the circuit breaker contacts "E" and a sharp "ping" as the signal arm strikes the bottom plate (shown removed), announcing the eggs are as ordered.

Your new product may demand equally accurate operation. Whether your aim is temperature indication or control, the right type of thermostatic bimetal is available among the twenty-nine types offered by the W. M. Chace Co. Chace Thermostatic Bimetal is furnished in completely fabricated elements of customers' designs or in strips, coils and random lengths. Write without obligation for your copy of our 64-page handbook on design and selection of bimetal, then call in our Application Engineers before tooling is actually started, and save time and money.

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description of the product, (2) the service conditions under which it must perform, (3) the advantages of porcelain enamel for this particular application, (4) the market for a product of its kind, and (5) present manufacturers of the product or its competition. The range of product suggestions was highly diversified and included items varying from hog feeders and ship bulkheads to various types of hoppers, housings, jet engine parts, receptacles, tanks, towers and area walls. In every instance, proved marketing benefits were shown for porcelain enamel, and sufficient marketing data were included to give a potential manufacturer a good clue to his possible success in locating and satisfying an existing market.

Due to the value of the study and the fact that it was produced entirely by the various active committees of the Porcelain Enamel Institute, the compilation has been restricted to membership use. The purpose of the study and the manner in which it has been compiled should be of specific interest to other associations and companies which may wish to pursue a similar course.

● The complete exhaust system of motor trucks is being given a coating of special heat resisting porcelain enamel to eliminate the corrosive influence of hot exhaust gases and to insure against rusting.

New Tests Detects Non-Wettable Soils on Metals

A new test has been devoloped by Columbia University's School of Engineering for detecting the presence of oils, greases and fats on metal surfaces to be plated. The research work was done by Edward B. Saubestre, a graduate student at Columbia and holder of an American Electroplaters' Society fellowship.

A general investigation into the cleaning and preparation of surfaces for electroplating was launched at Columbia during the summer of

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a complete **PLANT**

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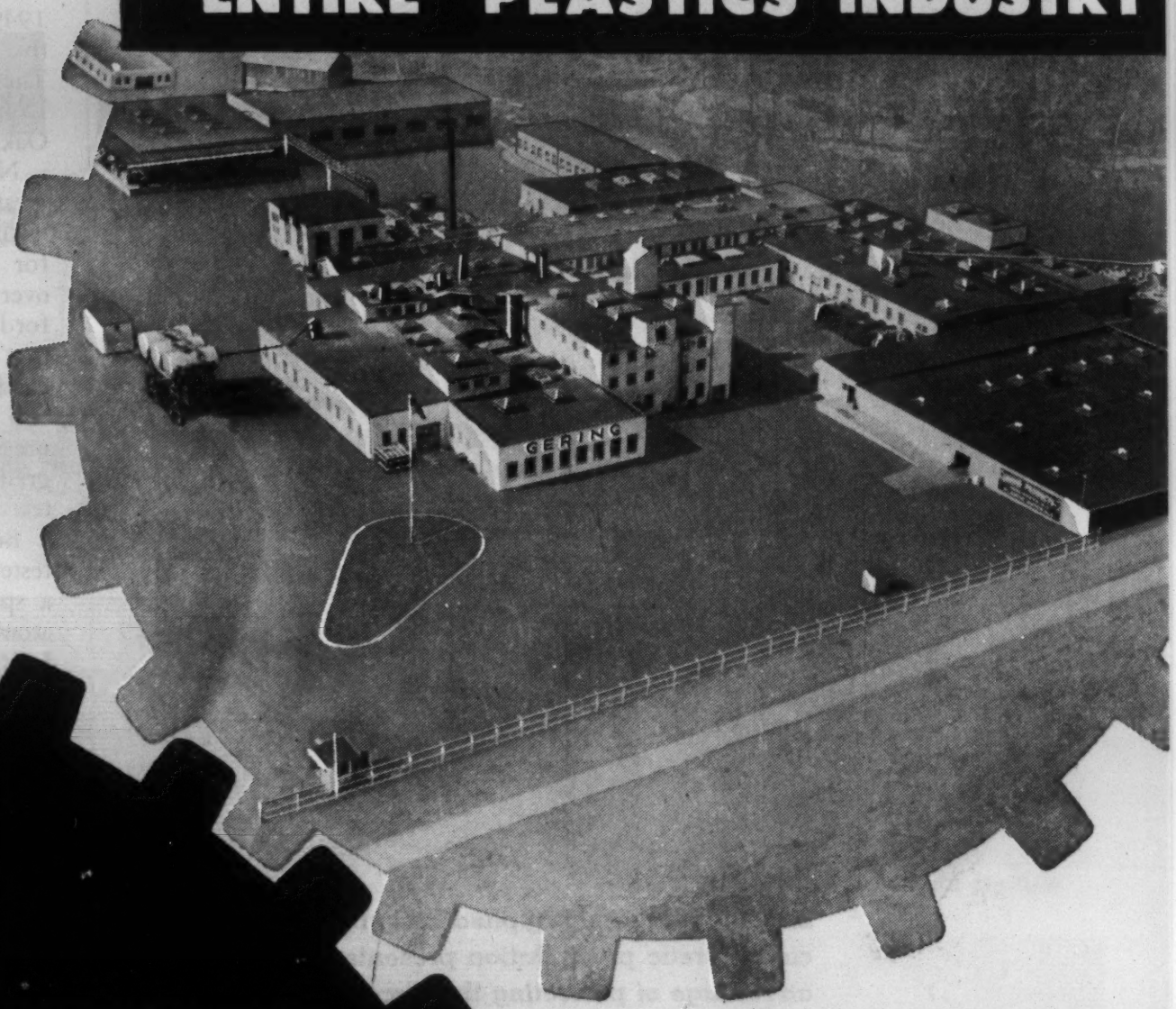

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News Digest

1949. It is supported by a grant from the American Electroplaters' Society. The Committee is headed by Dr. Donald Price, technical director for Oakite Products, Inc.

Named the "atomizer test" by its creators, the new oil and grease detecting method is remarkable both for its simplicity and its superiority over previous tests. Professor Linford explained it this way: "All that's needed is an atomizer selling for $1.50, a supply of distilled water, and a source of compressed air at a pressure of nine psi. A high school graduate could learn to operate the test in a day's time."

Briefly, a panel of metal to be tested is hung up dry, then bathed in a spray of distilled water from the atomizer, which is about 2 ft away. In from 30 to 45 sec the spray is shut off and the panel inspected. Where no grease or oil is present, the fine droplets of water coalesce and form a smooth film; the presence of these soils on the metal, however, causes the droplets to stand out like tiny beads from the greasy surface.

By careful investigation, Saubestre found the atomizer test 160 times more sensitive than the oldest, most common wetting test used to detect grease on metal after cleaning in an alkaline dip. In solvent cleaning, where the residual mixture of grease, oil or fat is spread uniformly over the metal, the atomizer test proved 10 times as sensitive.

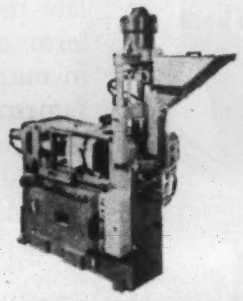
Already some half-dozen firms that do electroplating are using the atomizer test. Inquiries have come in steadily from other companies at the rate of two-a-week, or better.

It is expected that the atomizer test will rapidly replace the older waterbreak test, which has been used by commercial electroplaters for many years. The waterbreak method involves dipping the panel to be tested into water, then examining the surface for the continuous film of water that indicates a clean piece of metal.

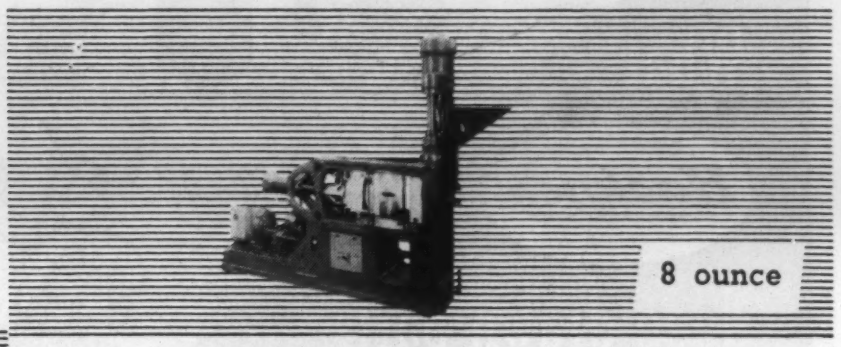
Other methods for detecting grease, oil and fat on metal have been tried—such as detecting the removal of radioactive carbon mixed with the grease with a Gieger counter and taking photos of a panel that's been made fluorescent. But all known tests have been compared with the atomizer method and none found more sensitive or more reli-

LESTER

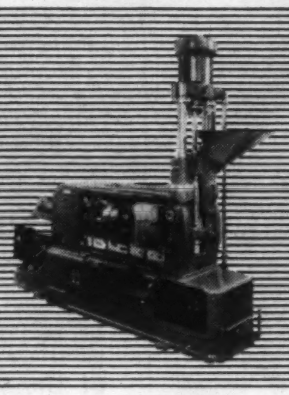
the preference of leading molders



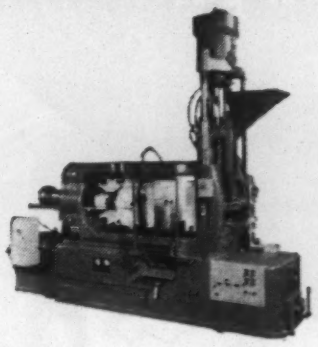
4 ounce



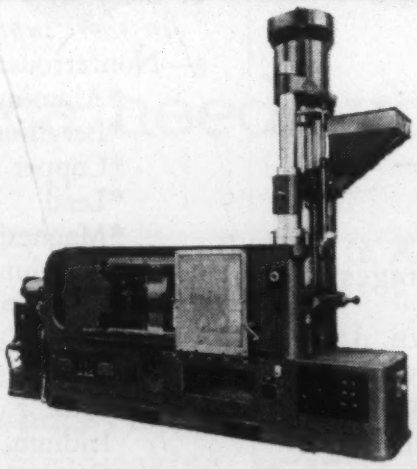
8 ounce



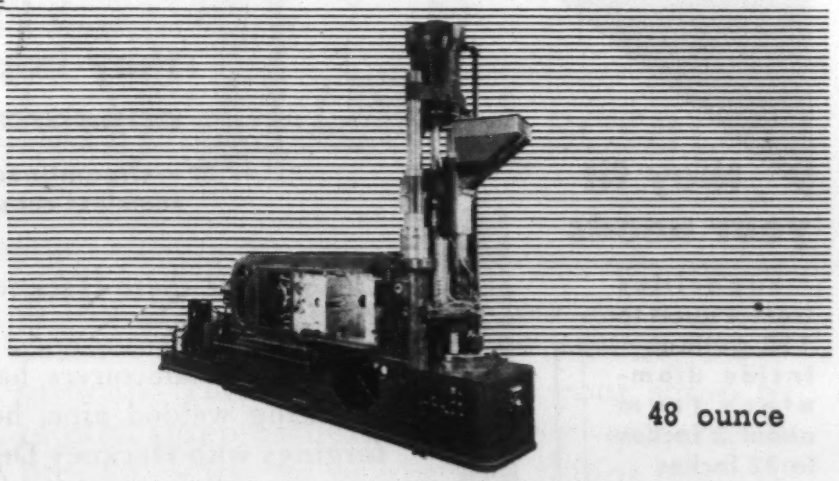
12 ounce



20 ounce



32 ounce



48 ounce

Only Lester Injection Molding Machines, ranging from 4 to 48 ounces, gives you these important features: "TORRID-ZONE" INTERNAL HEAT FOR GREATER PLASTICIZING; ONE-PIECE CAST STEEL FRAME FINISHED WITH DIE-MAKER'S PRECISION; SINGLE POINT DIE HEIGHT ADJUSTMENT; THE VERTICAL INJECTION SYSTEM.

A specially prepared file folder with complete specifications of the machine of your choice is available on request—or check with the representative in your area listed below.

LESTER INJECTION MOLDING MACHINES

distributed by LESTER-PHOENIX, INC., 2653 CHURCH AVENUE • CLEVELAND 13, OHIO

REPRESENTATIVES

New York . . . . . Steven F. Krould
Detroit . . . . . Thoreson-McCosh
Chicago . . . . . J. J. Schmidt
Cleveland . . . . . Don Williams
Cincinnati . . . Index Machinery Corp.
Los Angeles . . Seaboard Machinery Co.
San Francisco . . . . . J. Fraser Rae
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FOREIGN

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London, England . . Dowding & Doll, Ltd.
Calcutta, India . . Francis Klein & Co., Ltd.
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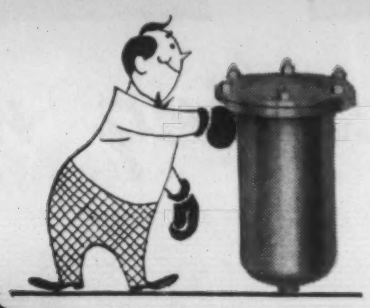
they save weight

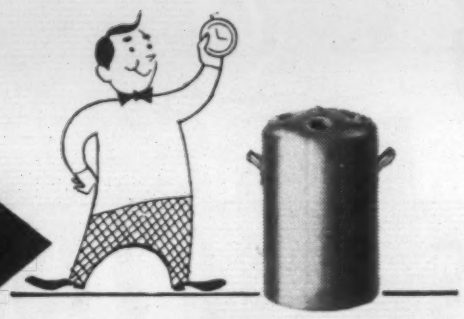
—cold drawn metal does the work of welded pipe, heavy forgings or castings.



they add strength

—shaped under pressure from one piece of sheet metal.

What Hackney MILWAUKEE deep drawn parts can do for YOUR products



they save production time

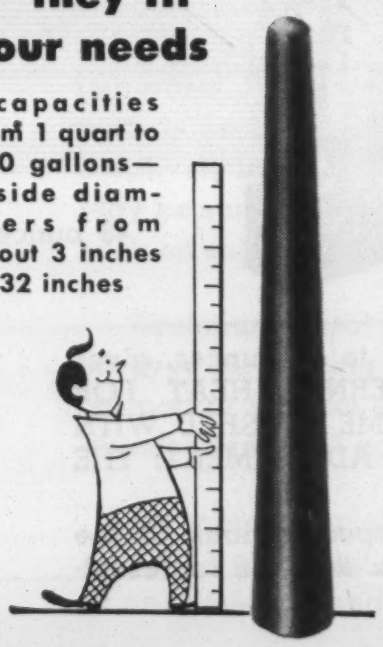
—eliminate many time-consuming welding and machining operations.

they improve appearance

—streamlined shapes—seamless construction.

they fit your needs

—capacities from 1 quart to 110 gallons—inside diameters from about 3 inches to 32 inches



Can you use these Hackney advantages to your advantage?

Many manufacturers have done so—by replacing welded pipe, heavy castings or forgings with Hackney Deep Drawn Parts.

Hackney Deep Drawn Shapes and Shells add product features which your customers appreciate—make your products easier and less costly to manufacture. They're backed by our 50 years of specialized experience—are made to *your* specifications.

Hackney engineers will be glad to help you design special shapes to meet your product requirements. Send us a sketch of your needs today.

Hackney MILWAUKEE **Pressed Steel Tank Company**

Manufacturer of Hackney Products

1442 South 66th St., Milwaukee 14 ° 241 Hanna Bldg., Cleveland 15
1319 Vanderbilt Concourse Bldg., New York 17 ° 936 W. Peachtree St., N.W., Room 111, Atlanta 3
208 S. LaSalle St., Room 788, Chicago 4 ° 559 Roosevelt Bldg., Los Angeles 14

CONTAINERS FOR GASES, LIQUIDS AND SOLIDS

News Digest

able. From a practical viewpoint, other methods have also been found too complex and expensive for the average plating establishment.

● Supplies of copper increased in the late months of 1951, and the long-term outlook was for major boosts in output of the metal, according to James J. Russell, chairman of Revere Copper and Brass, Inc. He describes requests from Washington to substitute aluminum for copper as "in the main unsound."

NPA List of Basic Metals and Alternates

The Defense Production Administration has published the following list of metals, classified as to their relative availability at the beginning of the year.

In short supply (most critical):*

a—Nonferrous:
- *Aluminum
- *Beryllium
- *Copper
- *Lead
- *Magnesium
- *Selenium
- Titanium
- *Tin
- *Zinc

b—Precious:
- Iridium
- Osmium
- *Platinum

c—Ferrous alloying elements:
- *Cobalt
- *Columbium
- *Molybdenum
- *Nickel
- *Tantalum
- *Tungsten

d—Ferrous:
- Bars, cold drawn
- *Alloy
- Carbon steel
- Castings:
- Carbon steel
- Gray iron: heavy, over 3000 lb
- Gray iron alloy: heavy, over 3000 lb
- Steel, low alloy:
- Corrosive resistant

America needs your daily pound of scrap

IF every man, woman and child in America provided one pound of scrap each day, they would supply just about enough to produce the 105 million tons or more of new steel that the industry hopes to make in 1952.

Like yeast in breadmaking, scrap is essential to steelmaking. Scrap speeds up the process because scrap is already-refined steel. Every ton of scrap used replaces one ton of pig iron. Thus scrap also saves raw materials, because each ton of pig iron represents two tons of iron ore, one ton of coal and half a ton of limestone.

The continuing co-operation of every reader of this page is urgently requested to overcome a scrap shortage daily growing more critical. Turn in--by selling your scrap to regular scrap-gathering channels--any and all broken, worn-out or obsolete things made of iron and steel--machines, tools, pipe, boilers, structural parts and other "junk" you'll probably never use again.

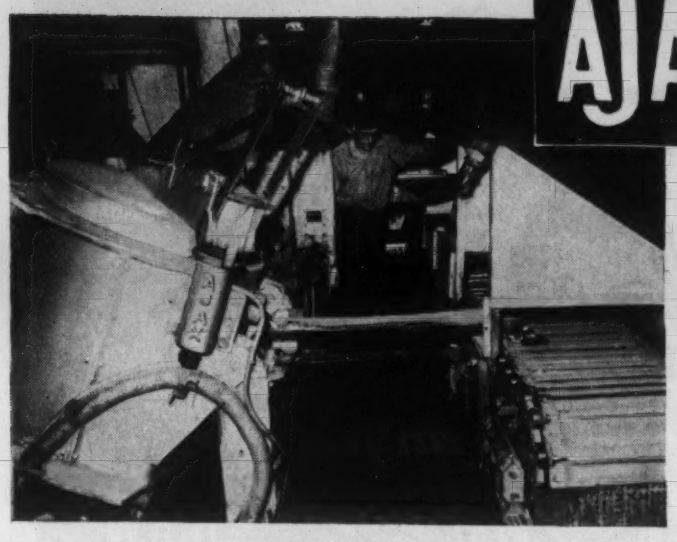
Do your part in the campaign to help meet America's need for more steel. Enlist now for the duration. Remember that the scrap you furnish may help you get more steel.

YOUR SCRAP YOUNGSTOWN IS NEEDED

The Youngstown Sheet and Tube Company

General Offices--Youngstown 1, Ohio
Export Offices--500 Fifth Avenue, New York
MANUFACTURERS OF CARBON ALLOY AND YOLOY STEELS

The steel industry is using all its resources to produce more steel, but it needs your help and needs it now. Turn in your scrap, through your regular sources, at the earliest possible moment.



AJAX INDUCTION FURNACES

help reclaim MILLIONS OF POUNDS of aluminum per year

AT LEFT
166 kW AJAX Induction Furnace in tilted position, pouring molten aluminum alloy through a coated trough into ingot molds on conveyor.

ONE OF THE COUNTRY'S LARGEST AUTO MAKERS

has an interesting setup for reclaiming aluminum alloy chips, which is installed next to the piston casting setup. More than half of the aluminum needed for pistons in this plant comes from this scrap recovery program, which makes use of two 166 kW AJAX Induction Furnaces for melting and pouring the aluminum alloy through a coated trough into ingot molds on a conveyor.

AJAX Engineering Corp. makes low frequency induction furnaces in a great variety of sizes, from 20 to 1000 kW.

Send for Reprint of Article on Scrap Recovery by Induction Furnaces

AJAX TAMA-WYATT

AJAX ENGINEERING CORP., TRENTON 7, N. J.

INDUCTION MELTING FURNACE

AJAX ELECTRO METALLURGICAL CORP., and Associated Companies
AJAX ELECTROTHERMIC CORP., Ajax Northrup High Frequency Induction Furnaces
AJAX ELECTRIC CO., INC., The Ajax Hultgren Electric Salt Bath Furnace
AJAX ELECTRIC FURNACE CORP., Ajax Wyatt Induction Furnaces for Melting

One Sure Way to CUT COSTS!

use a C-F SHEET LIFTER

The A. B. Dick Company, Niles, Illinois, found that this C-F Lifter has substantially reduced man hours and crane time required to move stock in and out of storage.

Up to 10,000 lbs. of high grade sheets in varying widths may be picked up, carried and unloaded at shears or machines with speed and economy by the Lifter and its operator.

C-F Lifters are made in standard or semi-special models to handle from 2 to 60 tons. Bulletin SL-25 describes the advantages you can obtain from C-F Lifters. Write for it today.

CULLEN-FRIESTEDT CO.
1314 South Kilbourn Avenue • Chicago 23, Illinois

News Digest

*Heat resistant
Die blocks
Forgings, heavy
Iron powder
Pig iron, low phosphorus
Pipe:
Seamless, all sizes
Welded, 4 in. and over
Plate, tin
*Plates
Rails
Rope wire, galvanized
*Shapes, structural
Sheet galvanized
Strand wire, galvanized
*Stainless steel: nickel-bearing
*Tubing, seamless:
Alloy mechanical
Alloy pressure
Carbon mechanical
Carbon, pressure
Wire, barbed
Wire, drawn: welding quality

In approximate balance:

a—Nonferrous:
Antimony
Bismuth
Cadmium
Calcium
Germanium

b—Precious:
None

c—Ferrous alloying elements:
Chromium
Manganese
Vanadium

d—Ferrous:
Forgings, medium
Pipe welded: 3 in. and under
Pig iron (other than in Group I)
Sheet (except galvanized)
Strip: hot rolled
Wire, drawn (except welding quality)

In fair to good supply:

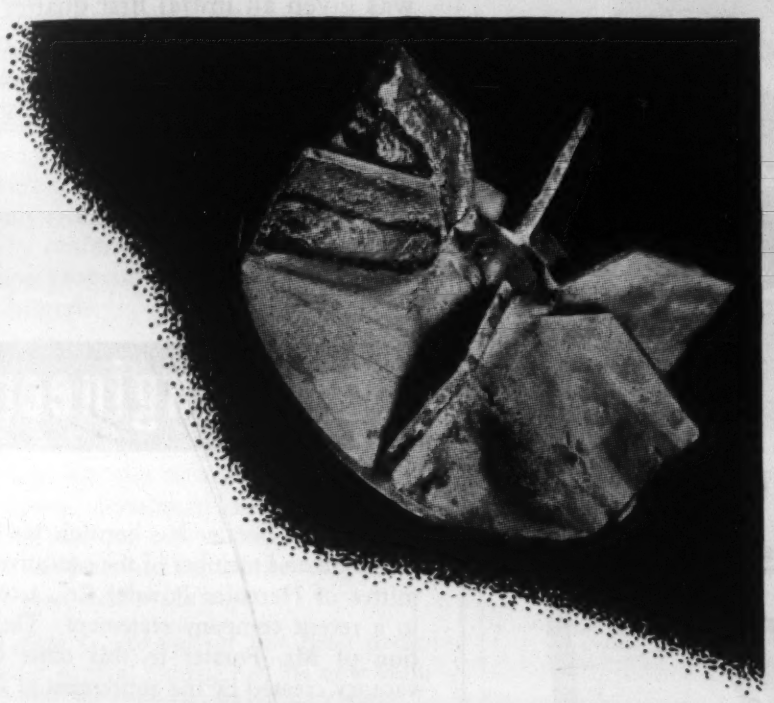
a—Nonferrous:
Mercury

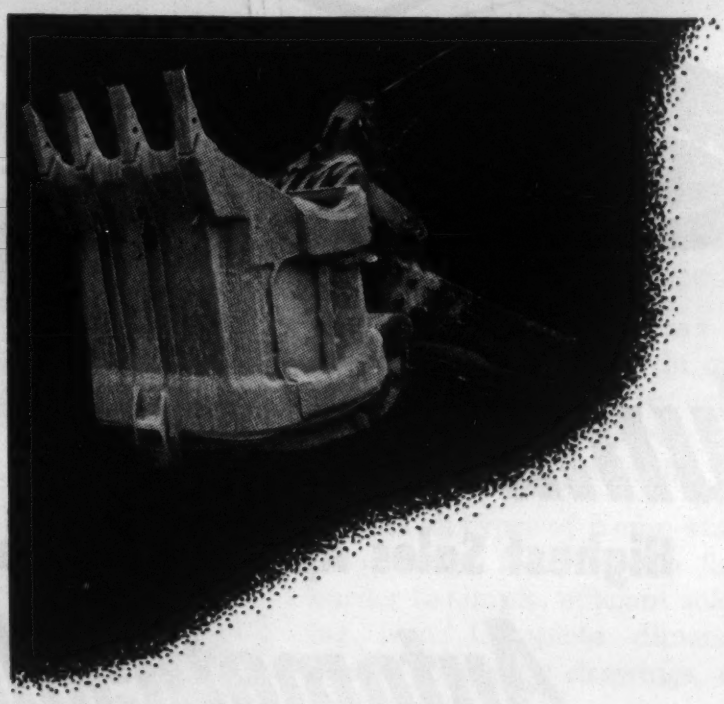
b—Precious:
Gold
Palladium
Rhodium
Silver

c—Ferrous alloying elements:
Boron
Tellurium
Titanium (ferro)
Zirconium

d—Ferrous:
Castings:
Gray iron alloy, lightweights
Gray iron (light and intermediate weights)
Iron malleable

NAME YOUR HARD-FACING JOB!





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hard-facing electrodes will do it . . .

★ *BETTER*

★ *FASTER*

★ *CHEAPER*

EXPERIENCE PROVES that to reclaim worn equipment and parts . . . to hard-face against excessive wear . . . *Wear-Arc* hard-facing alloys are tops. Equipment life is increased three, four, or more times . . . welds last longer . . . resist abrasion and impact better. Use the seven basic *Wear-Arc* types, singly or in combination — then judge for yourself, strictly on the basis of *results*.

★Contact your Alloy Rods Distributor or write for Wear-Arc Bulletin 5651.

Alloy Rods Co.

ALLOY RODS COMPANY

No Finer Electrodes Made . . . Anywhere

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Highest Sales Appeal at Lowest Cost

Automatically

Tumb-L-Matic's "Pushbutton" Processes – equipment, compounds, and techniques – AUTOMATICALLY add the finishing touches to an appealing product sales picture...and at a substantial savings. These processes provide closer control over finishing operations...enhance the saleability of your plastic products by lowest-cost, high-speed definning, cutting, smoothing, and lustering operations. When properly applied, they eliminate costly buffing...free vital manpower for more productive work.

Tumb-L-Matic's extensive line of machinery and compounds, backed by a quarter-century of experience with a wide and broadening range of materials, permit the "tailored" selection of cost-saving *standard* processes to fit your particular products and production layout.

8200

Write and tell us about your product finishing problems...or SEND A SAMPLE FOR COMPLETE ANALYSIS AND RECOMMENDED FINISHING PROCESSES

TUMB-L-MATIC, INC.

FORMERLY LUPOMATIC INDUSTRIES, INC.

4510 BULLARD AVENUE • NEW YORK 70, N. Y.

News Digest

Forgings, small
Stainless steel: straight chromium
Strip: cold rolled
Tool steel
Tubing, welded: carbon, mechanical

● The International Materials Conference announced a preliminary division of the free world's cobalt supplies for the first quarter. The U. S. was given an initial first quarter allocation of 1,082 metric tons of cobalt metal, oxides and salts. This was out of a preliminary world-wide distribution of 1,431 metric tons.

News of Engineers

Albert E. Forster has been elected a vice president and member of the executive committee of Hercules Powder Co., according to a recent company statement. The election of Mr. Forster to this office fills a vacancy created by the retirement of *Petrus W. Meyeringh.*

The Watson-Stillman Co. has announced the appointment of *Adolph J. DeMatteo* as chief engineer. Mr. DeMatteo joined the company in 1944 and since 1946 has held the position of assistant chief engineer.

Carl S. Hallauer has been named executive vice president of Bausch & Lomb Optical Co.

Don S. Smith, general production manager of the Wellman Bronze & Aluminum Co., has been appointed vice president in charge of production.

Air Reduction Co. has announced the election of *Joseph H. Humberstone* as vice president. Mr. Humberstone was formerly the president of the company's Airco Equipment Manufacturing Div., and he has been succeeded in that capacity by *Scott D. Baumer.*

The retirement of *Frank W. Smith,* vice president in charge of Norton Co.'s Grinding Machine Div., has been announced by the company. Mr. Smith will remain with the company as a consultant responsible for the construction of the new Machine Div. expansion program but will relinquish responsibility for the operation of the di-

News Digest

vision to *Everett M. Hicks,* manager.

Dr. *A. Lloyd Taylor* has been appointed director of research in the research laboratories of MacDermid Western, Inc. Dr. Taylor will work in the field of industrial detergents chiefly for use in the field of metals.

Tube Reducing Corp. has announced the appointment of *Kenneth W. Donle* as chief metallurgist. For the past six years, Mr. Donle has held the post of assistant chief metallurgist for the Gary, Ind. plant of the National Tube Co.

Dr. *Francis C. Frary,* director of research for Aluminum Co. of America, has retired from the company. Dr. Frary was the founder of organized research in the aluminum industry, and organized the Aluminum Research Laboratories at New Kensington.

General *E. R. Quesada,* retired, has been elected vice president and director of Olin Industries, Inc. General Quesada, who recently retired from the Air Force, will be directly concerned with the company's expansion program in the field of cellulose and minerals.

The appointment of *William R. Miller* to the post of manager of the Metallurgical Dept. of American Steel & Wire Co. has been announced. Also announced by the company was the retirement of *James R. Thompson,* a national authority on cold heading and one of the deans in his field. Mr. Thompson had served the company for more than half a century.

Warren G. Rosendahl has been named assistant general manager of its new Hamilton Div. by Clearing Machine Corp.

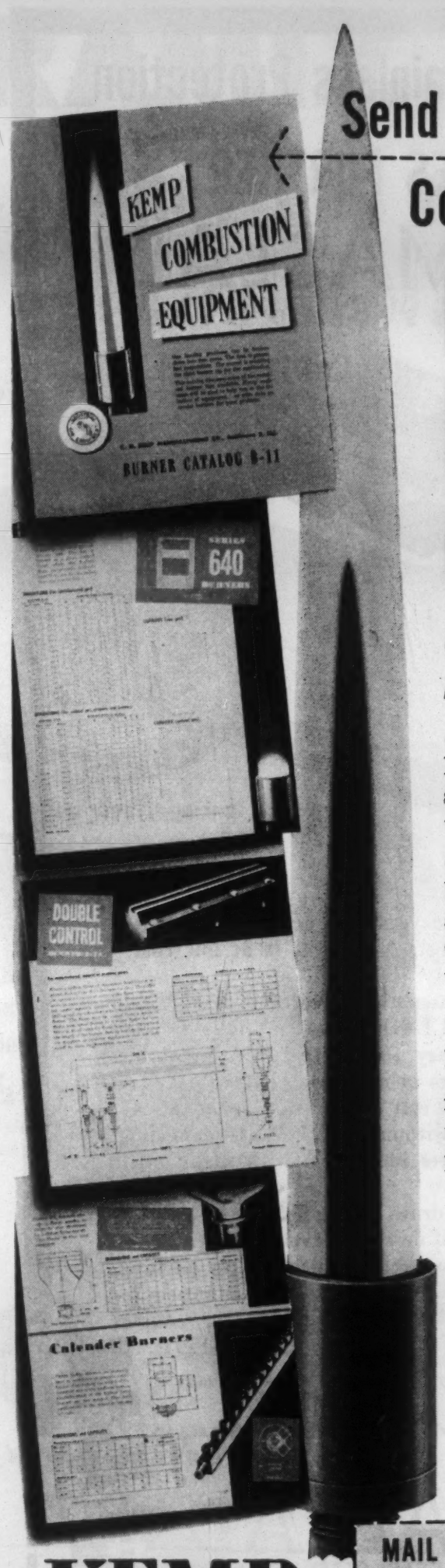
Robert A. Graney has been appointed to the newly created post of assistant general superintendent of Inland Steel Co.'s Indiana Harbor Works.

The appointment of *John Waldherr, Jr.* to the position of director of engineering has been announced by the Chefford Master Manufacturing Co. Mr. Waldherr has served the company as chief design engineer since 1949.

R. B. Blythe has been made executive chief engineer of the Bryan factory, Aro Equipment Corp. Mr. Blythe will have complete responsibility for all engineering and experimental activities in aircraft products, pneumatic tools and lubricating equipment.

Norman E. Carlson has been named assistant chief mechanical engineer of the American Car and Foundry Co.

Two General Electric authorities in the field of mercury arc power rectification have been named Fellows of the American Institute of Electrical Engineers. The G-E engineers are *Lyle W. Morton* and *August Schmidt,* who are employed in the Power Electronics Div. of the firm's Industrial Engineering Divs. Recent appoint-



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Get the answers to your industrial heating problems

● Tells how Kemp Combustion Equipment offers you dramatic savings, is easier to install, easier to maintain, cheaper to operate.

● Shows unique features and basic principle involved in operation of the Kemp Industrial Carburetor. Complete with illustrations and capacity tables.

● Lists all types of Kemp standard burners from ribbon flame burner to simple, efficient soldering iron. Complete dimension tables, schematic drawings, output charts.

Whatever your heating problems, there's a Kemp burner to fit your needs. If you have a specific heating problem, Kemp engineers will make a special recommendation to suit your operation. You'll find this new book valuable to keep on hand for reference alone. Write today for your individual copy.

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Please forward at once your latest FREE Burner Catalog "Kemp Combustion Equipment."

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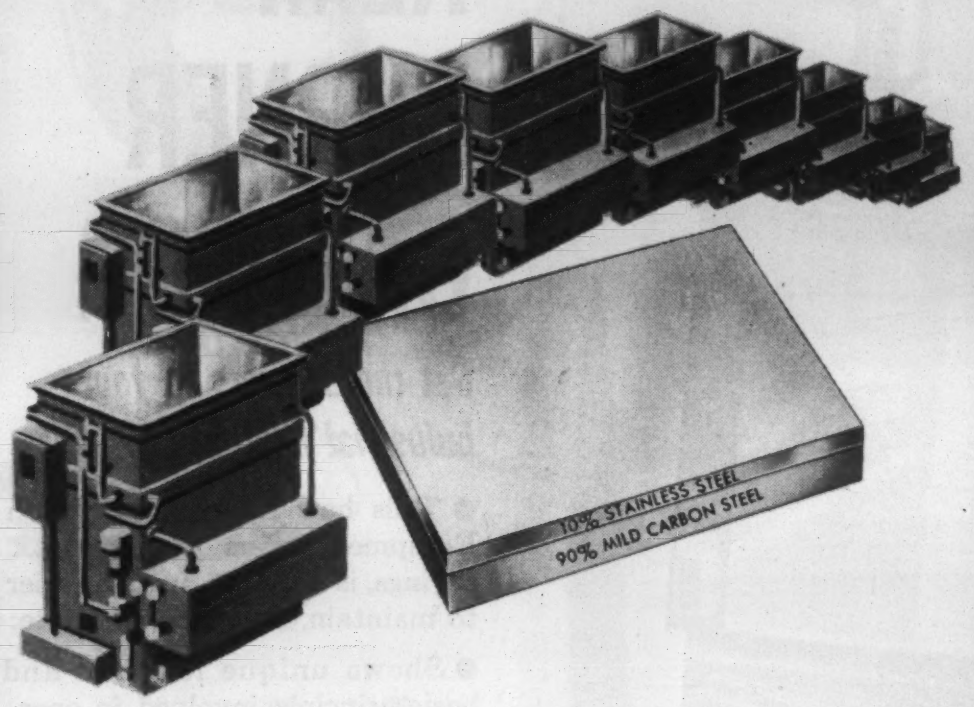
How to Make Stainless Protection Go NINE TIMES FURTHER... with PERMACLAD

STAINLESS CLAD STEEL



Want stainless protection for your product or equipment—without wasting stainless steel? You'll get it at low cost—with PERMACLAD!

A 10% layer of stainless, inseparably welded to a 90% mild steel backing, gives PERMACLAD the surface characteristics of solid stainless *and* the easy forming qualities of carbon steel. This means real savings in corrosion resistance and in fabrication as well. For you can cold-form PERMACLAD with ease, draw it deeper without intermediate annealing, actually form it into products impossible with many other materials.

Even with the most severe draw, the percentage of cladding (which can be 20% or more if desired) never varies. And the stainless layer remains inseparably welded to its backing. For gleaming, stainless products and corrosion resistant equipment, design and build with PERMACLAD. The coupon below brings you full details in our new 8-page folder (P-97).

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PERMACLAD

STAINLESS CLAD STEEL

STEEL SCRAP FIGHTS FOR DEFENSE. SELL YOUR SCRAP NOW!

ALAN WOOD STEEL COMPANY Conshohocken, Pa.

Over 125 Years of Iron and Steel Making Experience

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Company _____

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Other Products: A.W. ALGRIP ABRASIVE Floor Plate • A.W. SUPER-DIAMOND Floor Plate • Plates • Sheets • Strip • (Alloy and Special Grades)

News Digest

ments within the company's organization include: *Royce W. Hill* of the Chemical Div. has been named supervisor of production at the phenolic products plant in Pittsfield; *Richard T. Walsh,* also of the Chemical Div., has been named superintendent of the Division's Coshocton, Ohio plant; *H. Arthur Howe,* manager of G-E Chemical Div.'s phenolic products plant at Pittsfield, has been appointed manager of the Division's Coshocton plant. *Arthur T. Bourgault,* department manufacturing analyst, will succeed Mr. Howe.

James E. Young, ceramic engineer, has been named an associate ceramic engineer in the Ceramics and Minerals Research Dept. at Armour Research Foundation, Illinois Institute of Technology. *John C. Lee,* assistant engineer in the Mechanics Dept. at Illinois Institute of Technology, has been appointed assistant engineer in the Heat-Power Dept. at the Foundation. *Cecil Schwartz,* stress analyst, has been named an associate engineer in the Heat-Power Research Dept., and *Leonard L. Johnson* has been appointed an associate engineer in the Mechanism and Propulsion Research Dept. of the Foundation.

Grover C. Hansen, manager of sulfuric acid production in the Grasselli Chemicals Dept. of du Pont, will retire after more than 40 years with the department and its predecessor, The Grasselli Chemical Co. Upon his retirement, sulfuric acid production supervision will be assigned to *Alvin A. Corey,* Grasselli production manager.

Appointment of Dr. *Lauriston C. Marshall* as director of Link-Belt Co.'s new Physical Testing and Research Laboratory has been announced by the company.

General *Donald Armstrong,* president, United States Pipe and Foundry Co., has resigned as president and director to accept an important post abroad in connection with the economic mobilization in Europe. *N. F. S. Russell,* chairman of the board, has been elected president.

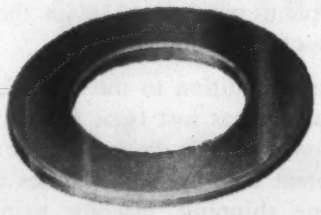
The Richardson Scale Co. has announced the death of its founder and chairman of the board, *Mr. Henry Richardson.*

News of Companies

Continuing a program of expansion in aluminum fabrication, *Revere Copper and Brass, Inc.* will extend aluminum operations to the Pacific coast as rapidly as feasible, by approximately doubling the size of

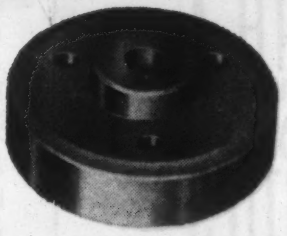
fifteen GRAMIX® parts that save time, money and machining

die pressed of powdered metal mixtures . . . oil impregnated for self lubrication

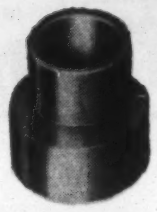


iron-copper thrust washer 4¢

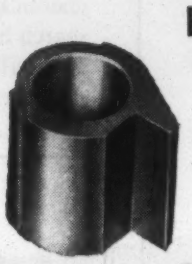
iron pivot bearing 23¢



bronze ratchet hub 23½¢

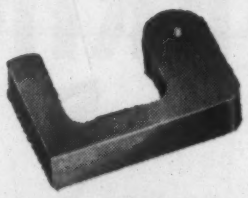


bronze eccentric hub bearing 6½¢

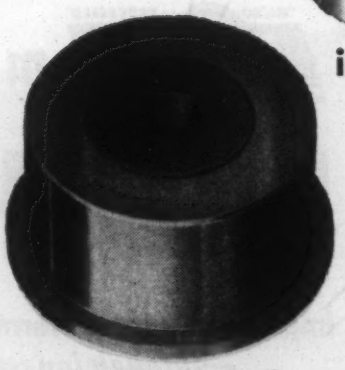


iron cam 5½¢

copper fuse end 1½¢

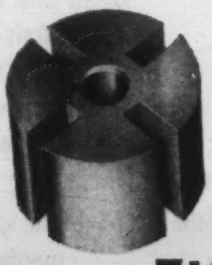


iron tripper 5¢



gramix backed graphitar roller 85¢

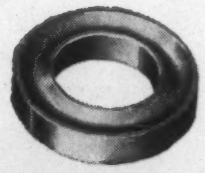
nickel silver gear 3½¢



iron rotor 7½¢

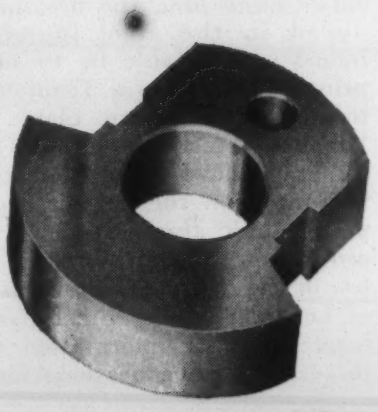
bronze bearing plate 9¢

eccentric supporting bearing 2½¢



iron pump gland part 1½¢

switch take-up washer 7¢



iron ironer cam 10¢

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Scientific schools and groups of designers, engineers, metallurgists and technical societies can *now* secure the *free* use of this full-color sound film, the first produced in the steel foundry industry. Available in 16 mm prints, the film is a 37-minute tour of the modern plant of Lebanon Steel Foundry. The camera follows jobs from the blueprints on the project engineer's desk through steps of production to show, finally, a few of the many important uses of Lebanon quality Steel Castings. Write for information on this exciting and educational film.

LEBANON STEEL FOUNDRY
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In the Lebanon Valley

LEBANON ALLOY AND STEEL castings

News Digest

the present Los Angeles Revere plant, according to a recent company statement. A target date of the spring of 1953 has been set for operation of the addition to the Los Angeles plant, which is to cover about 50,000 sq ft and add over 100 employees to the company. The plant will produce aluminum tube and extruded shapes in a variety of alloys.

Mallory-Sharon Titanium Corp. has moved its general offices from Indianapolis to Niles, Ohio. The headquarters of the company are at the Niles Rolling Mill Co. plant.

An expansion program, costing in excess of five million dollars, to greatly increase the production capacity of the *General Electric* silicone plant has been announced by the company.

A two-story office building has been newly acquired and a full city block leased by *Atlantic Research Corp.* The new building, for housing the executive offices of the chemical and chemical engineering research firm, adds 3000 sq ft to the premises, and will release more space for laboratory purposes.

Concurrent with its tenth anniversary, the *Nelco Tool Co.* has announced the completion of its new building program, more than doubling its manufacturing space.

A new 2½ million continuous galvanizing plant will be under construction shortly, according to a recent announcement from *Wheeling Steel Corp.* The building housing the new plant will be known as Martins Ferry Factory No. 2, a part of the main plant at Martins Ferry, Ohio.

Charles H. Besly & Co. has changed its corporate title to *Besly-Welles Corp.*

A new 26,000-sq-ft factory expansion has just been completed at Cheboygan, Mich., by *Detroit Tap and Tool Co.* The plant was constructed to take care of the company's increased production of taps, thread gages, thread milling cutters and other threading tools.

The Swedlow Plastics Co. has started construction on its third manufacturing facility at Los Angeles. This new 36,000-sq-ft plant will also contain the general offices of the company.

A new addition to the *Colonial Broach Co.* factory has just been completed. The addition, which increases machine construction plant area by 30%, houses expanded machine shipping, machine painting and machine assembly facilities.

Sierra Drawn Steel Corp. recently held

"MICRO-...-PROCESSED" I-S BERYLLIUM COPPER SPRINGS

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Improved motor performance
—through longer brush life

Cut costs
—by reducing assembly time

Check your brush springs against these I-S features . . .

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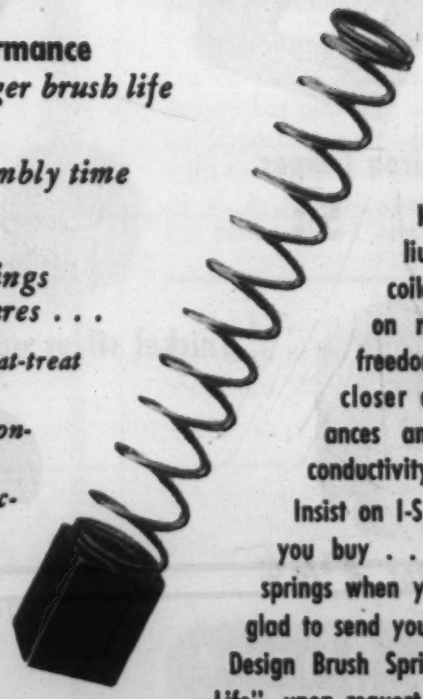
- ✓ **UNIFORM PRESSURE**—*electronically gauged*
- ✓ **GUARANTEED MINIMUM VARIATION IN BRUSH PRESSURE**—*resulting in minimum brush wear*



Heat-treatable beryllium copper wire—coiled and heat-treated on mandrels—results in freedom from set or drift, closer dimensional tolerances and higher electrical conductivity.

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Our facilities include a wide range of both fusion and resistance welding equipment, applicable to ferrous and non-ferrous metals. We have welded aluminum and copper in addition to carbon, alloy and stainless steels; Inconel, Monel and NAX. We believe we were the first to successfully flash butt weld titanium. And we believe that possibly we can help you with your present or new production program if you will let us put our third of a century's experience to work for you. We will be glad to discuss it with you — just drop us a line.

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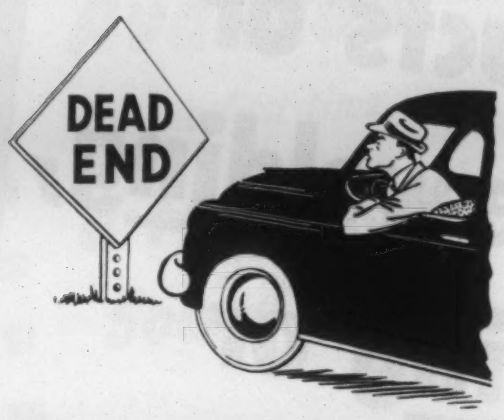

Is Your Trained Manpower Bogged Down in the Blind Alley of Routine Jobs?

Among your valuable assets, trained manpower ranks at the very top. Yet if your skilled technicians are tied down to routine testing jobs, you are not only wasting your assets, but you are fanning the spark of dissatisfaction.

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Let's discuss the matter at your convenience. We are sure we can show you a better way of handling your routine testing.

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News Digest

open house to celebrate the completion of a 30% increase in plant area.

The Precision Shot Co. has completed expansion of facilities for its new Shot Peening Div. This division operates for industry as a pilot and contract production shot peening shop, and offers experimental facilities and consultation services to firms wishing to investigate the process.

The Pennsylvania Salt Manufacturing Co. has completed construction and begun operation of its new plant for the production of industrial cleaners, believed to be the first basic producer of its kind on the West Coast. The new plant will manufacture a complete line of specialty metal cleaners for a wide variety of metal-finishing operations.

Construction work on a new $365,000 research laboratory has been started by the *Chemical Div., Borden Co.* The laboratory, to be adjacent to the company's Durite molding compounds and industrial resins plant, is scheduled for completion by next June.

Cadillac Plastics Co. recently occupied new and larger quarters at 15111 Second Ave., Highland Park, Mich. The new building will more than double the company's former facilities.

Spencer Rubber Products Co. has recently entered the industrial molded rubber goods field, according to a recent company statement.

The *Meehanite Metal Corp.* has recently announced the winners of its Meehanite Casting Design Contest. This contest, open only to design engineers in manufacturing plants using castings, was aimed toward uncovering facts about new uses and applications of Meehanite castings, and uncovering problems solved by their specifications.

Henry & Miller Industries, Inc. has announced the recent opening of a new metal fabrication and finishing plant in Jersey City.

A major organizational change to enable the *American Can Co.* to place more emphasis on creative research through establishment of a new Research and Technical Service Dept. has been announced by the company. Designed to create and develop original ideas and techniques that will benefit the nation's consumers, canners and farmers, the department will consist of the Research, Development, Technical Service and Agronomy Divs.

Janney Machine Corp. has moved into its enlarged quarters at 2601 N. Howard St., Philadelphia 33. The new plant, with 10,000 sq ft of space, will allow for considerable expansion.

A new plant designed for the manufacture of Selectron, a polyester resin plastic, is currently under construction at Springdale, Pa., according to a recent announcement from *Pittsburgh Plate Glass*

CLEAR UP YOUR Grinding Jobs with the Right PELRON GRINDING COMPOUND

PELRON GRINDING COMPOUNDS, water soluble, produce a clear solution that not only prevents loading the finest grit wheel, but facilitates the work by enabling the operator to see the piece at all times.

PELRON GRINDING COMPOUNDS provide all the other desirable features of a grinding compound: excellent detergent properties, rapid settling of chips and grind particles, high rust preventive quality, stable in emulsion, neutral to the skin.

PELRON TECHNICAL SERVICES include, free, expert advice on facilitating many metal-working operations, through the use of PELRON special chemicals for industry: cutting oils, grinding, drawing and forging compounds, metal cleaners, rust preventives, etc., etc., etc. Write us regarding your special problems. We're always "looking for trouble"—with the object of licking it, reducing *your* worries, increasing *our* experience.

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Production Scrap *alone* won't make the steel you need!

Read what Defense Mobilizer Charles E. Wilson says:*

"In order to achieve the tremendous goal of 110,000,000 tons of steel this year, 36,000,000 gross tons of iron and steel scrap must be channeled back to the steel mills and foundries. That is 6,500,000 tons above what was needed in 1950. *Normal scrap recovery sources cannot produce such amounts. Emergency sources must be discovered and activated."*

**In a letter to the editor of* PLANT ENGINEERING, *Aug. 10, 1951.*

ALL OF US MUST DIG DEEPER—*GET OUT THE HIDDEN SCRAP!*

Your plant could be one of the emergency sources Mr. Wilson is talking about. Appoint a scrap and salvage team. Study plant layout to determine what can be scrapped. Then turn it up and turn it over . . . to your scrap dealer for cash.

Check your plant for obsolete, broken, worn-out and irreparable:

☐ machinery ☐ dies ☐ jigs ☐ fixtures ☐ tanks ☐ boilers ☐ rails ☐ pipe and fittings
☐ motors ☐ machine bases ☐ tools ☐ chain ☐ structural steel ☐ valves ☐ starters
☐ transformers ☐ castings ☐ steel barrels ☐ nuts and bolts

Sell them to your scrap dealer NOW!

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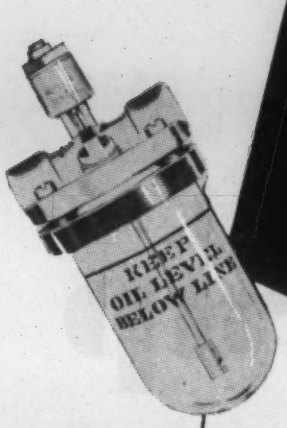
ACE PRECISION
NYLON BALLS
FOR EXACT CONTROL

SIZES 1/8" – 3/4"
TOLERANCES ±.001



C. A. Norgren Co., Denver, Colorado, uses Ace Nylon Balls as feed tube checks in Micro-Fog Lubricators to provide instant oil flow.

Ace Nylon Balls of DuPont Nylon FM #10001 are mass produced to close tolerances giving you the advantages of toughness at low temperatures, form stability at high temperatures, light weight, chemical and abrasion resistance.

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Precision Plastic Fabricators

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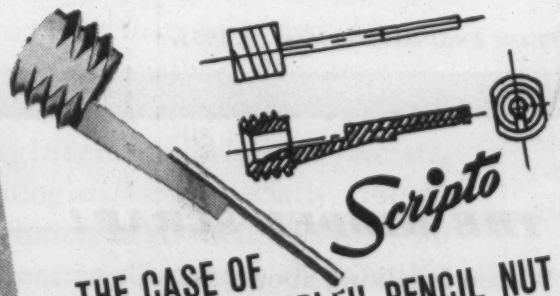

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Scripto's new design seemed impossible until GRC solved the problem with a zinc alloy precision die casting which made the intricate part practical.

This greater design flexibility resulted in a new product achieving far-reaching sales advantages . . . because Scripto decided to "ask GRC." Gries' exclusive facilities produce simple or intricate tiny parts in one automatic operation . . . completely trimmed, ready for use . . . . 100,000 parts or many millions.

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- Faster Production
- Close Tolerances
- Reduced Scrap Loss
- Simplification
- Product Improvement
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TINY ZINC DIE CASTINGS

SMALLNESS UNLIMITED
Max. Wt. ½ oz.
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News Digest

Co. The resin plant will adjoin the company's paint manufacturing facilities.

News of Societies

American Standards Association has announced the election of Roger E. Gay, president, Bristol Brass Corp., as president of the association. Edward T. Gushee, vice president, Detroit Edison Co., was elected vice president.

Reginald J. S. Pigott, director of the Engineering Div., Gulf Research and Development Co., was elected president of *The American Society of Mechanical Engineers* at the society's 72nd annual meeting. The new president succeeds J. Calvin Brown.

Charles S. Craigmile, president and director of the Belden Manufacturing Co., was recently named president of the *National Metal Trades Association* at the 52nd annual convention. Others elected to office were Earle S. Day, vice president and general manager of Collyer Insulated Wire Co., who was elected first vice president, and Norman L. Rowe, vice president of Ideal Roller and Manufacturing Co., who was named second vice president and treasurer.

Dr. Gerhard A. Nothmann, assistant chairman of the Mechanism and Propulsion Research Dept. of *Armour Research Foundation, Illinois Institute of Technology,* has been appointed department chairman. Dr. Harry Schwartzbart, research metallurgist for the National Advisory Committee for Aeronautics, has been appointed research metallurgist in the Metals Research Dept. at the Institute.

The American Society for Testing Materials has announced the establishment of an annual H. W. Gillett Memorial Lecture. The purpose of this lecture, which is being sponsored in cooperation with Battelle Memorial Institute, is to commemorate Horace W. Gillett, who was one of America's leading technologists, the first Director of Battelle, and an active worker for many years in ASTM. The lecture will be delivered annually at a meeting of the Society, the first to be given at ASTM's 50th Anniversary meeting in June, 1952. The lecturer, who will be selected through a committee appointed by the ASTM Board of Directors, will cover a subject pertaining to the development, testing, evaluation and application of metals.

Council of Association of Consulting Chemists and Chemical Engineers, Inc. has made the following appointments for 1952: Robert T. Baldwin, executive secretary and assistant treasurer, and A. B. Bowers, director of publicity and assistant executive secretary.

FOUR OPTICAL AIDS to help you SAVE MATERIAL and MAN-HOURS!

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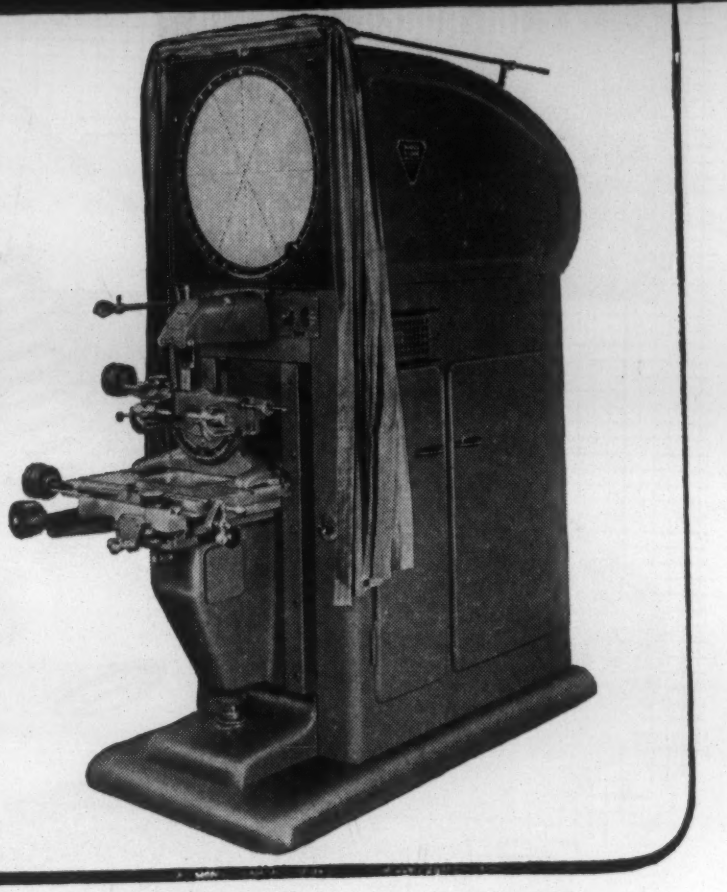
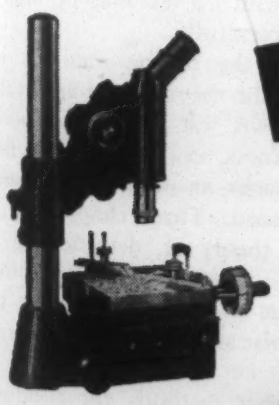


You save time and money by assuring *more accurate measurements than any other projector can give you.* You get angular measurements to ±1 minute of arc, with the protractor screen. You get direct linear measurements to ± .0001″ over a range of 4″x6″, with the cross slide stage.

You save time and money by spotting inaccuracies quickly and simply. Dimensions, angles, and profiles of production-run parts can be compared directly with a *traced outline* of the projected image of the master part, or with a large scale drawing superimposed on the screen. Catalog D-27.



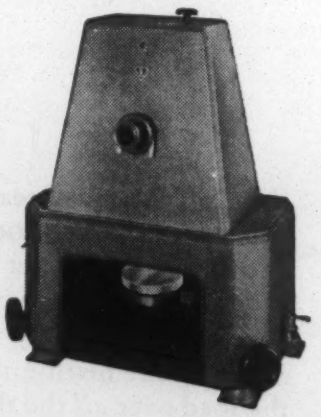
2 TOOLMAKERS' MICROSCOPE

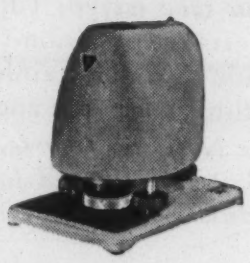
Linear measurements to ±.0001″, and, when fitted with a protractor eyepiece, angular measurements to ± 1 minute of arc, can be made with this sturdy microscope. Operation is extremely *simple* and *fast.* Opaque and transparent objects of any contour can be measured. *Catalog D-22.*

3 STEREOSCOPIC WIDE FIELD MICROSCOPES

Provide clear, sharp, 3-dimensional, unreversed, magnified images. Used extensively in industry for greater speed and accuracy in small parts assembly operations, inspection of tools and finished parts, and precision machining of small parts. 15 models for many uses. *Catalog* D-15.

New 4 PARA-PLANE GAGES





Now you can have "laboratory" accuracy of 0.000001″ in the determination of flatness and parallelism of reflecting surfaces... with production-line *simplicity* and *speed.* So simple that an unskilled operator can make measurements after a few minutes of instruction.

Two sizes of Para-Plane Gages are available: the larger (top) tests objects up to 6″ in diameter; the smaller (bottom) tests up to 3″ in diameter. *Bulletin* D-224.

WRITE for complete information on these 4 important optical aids designed to help you save time and money. You may be paying many times over their cost in lost time and rejects. Send your request to Bausch & Lomb Optical Company, 793-14 St. Paul St., Rochester 2, N. Y.

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Heli-Coil* screw thread inserts will increase the strength of threaded fasteners in your product . . . permits you to use smaller boss sections and fewer or smaller fastenings. You benefit through more compact, functional design, with substantial cost and weight savings.

You add strength by using ***Heli-Coil*** inserts because they automatically adjust to the mating threads, compensate for lead error, and distribute the load over *all* the threads.

You save weight (up to 75% over solid bushings) because ***Heli-Coil*** inserts are precision-formed coils with no "wall thickness". And they're made of tough stainless steel to free you from troubles like stripping, galling, corrosion and thread wear.

For National Coarse, National Fine and Unified threads in Classes 3, 3B, 2 and 2B, and for spark plugs and pipe threads. Conforms to all industrial and military specifications.

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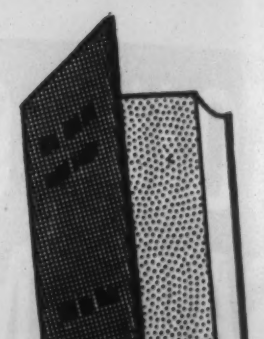

BOOK REVIEWS

Nondestructive Testing

THE NON-DESTRUCTIVE TESTING OF METALS. *By R. F. Hanstock. Published by The Institute of Metals, London, England. 1951. Cloth, 5¾ by 8¾ in., 163 pp. Price $3.50.*

In this book, nondestructive testing is not narrowly interpreted as the application of radiography, magnetic and ultrasonic methods to the detection of flaws in metals. Although these methods, now well known and applied in many industries, receive consideration, other, less well-known methods of examination are described with the object of providing a work of reference that may suggest alternative approaches to special problems of nondestructive testing. Particular methods of testing are seldom universally applicable, and one purpose of this book is to indicate the limitations within which a test may be expected to operate successfully.

Aside from the testing methods mentioned above, the theories and applications of lesser known tests, such as those to measure thickness, evaluate surface finish, and detect cracks at or near the surface, are also included. Three chapters are devoted to the theory of, detection of, and metallurgical conditions affecting damping capacity in an attempt to supply a background in this area of greatly increased interest.

Various other methods for conducting tests to determine the composition and condition of metals are also covered, and their inclusion gives the reader a broad technical description of the field of nondestructive testing.

Other New Books

MANUFACTURING EQUIPMENT AND PROCESSES. *By Charles W. Lytle and Arthur F. Gould. Published by International Textbook Co., Scranton 9, Pa., 1951. Cloth, 6½ by 9¼ in., Price $6.50.* The aim of this book is to clarify the technicalities of the most basic equipment and processes now used in the engineering shops of the United States.

FOUNDRY WORK. *By Edwin W. Doe. Published by John Wiley & Sons, Inc., New York 16, N. Y., 1951. Cloth, 6 by 9¼ in., 109 pages. Price $1.76.* This text has been prepared to teach the simple principles of foundry practice, first by referring to the several phases of the industry in a general way, thereby arousing interest in the subject, and secondly by arranging a series of molding problems that will exemplify the application of this knowledge in a practical manner.

MANUFACTURERS' LITERATURE

indicating its place in development of rubber products. (58)

Felt. Western Felt Works, 32 pp, ill. History of manufacture and uses of felt, including brief description of present-day methods and applications. (59)

Fabricated Wood. Woodall Industries, Inc., 16 pp, ill. Facilities for custom fabrication of industrial Masonite, versatile material that can be used more advantageously than wood, plywood, sheet metal or paper stock boards in many applications. (60)

Metal Parts • Forms

Welded Parts. Acme Tank & Welding Div., 4 pp, ill. Shows this plant's facilities for welding complex shapes and discusses advantages of using welded construction by competent welders. (61)

Malleable Iron Castings. Albion Malleable Iron Co., 20 pp, ill. Pictorial description of the growth and modernization of this plant's facilities for the production of malleable iron castings. (62)

Aluminum Extruded Shapes. Aluminum Co. of America, No. AD-229. Explains potentialities of extrusion process for aluminum as money-saver in fabrication operations. (63)

Condenser Tubes and Plates. American Brass Co., 44 pp, ill, No. B-2. Discusses application and installation of condenser and heat exchanger tubes and plates and the factors affecting service life. (64)

Zinc Die Castings. American Die Casting Institute. Bulletin describes Certified Zinc Alloy Plan, explaining benefits to die casting buyers. (65)

Continuous-Cast Copper Alloys. American Smelting and Refining Co., 12 pp. Technical data on company's continuous-cast copper alloy rods, tubes and shapes. (66)

Precision Investment Castings. Arwood Precision Casting Corp., 16 pp, ill. Informative article on precision investment castings. Includes table of alloys recommended as most adaptable for this process. (67)

Precision Castings. Atlantic Casting and Engineering Co., 721 Bloomfield Ave., Clifton, N. J. "Quality Precision Castings for Industry" explains advantages of plaster mold process, gives specifications on this firm's alloys. Request direct from Atlantic on company letterhead.

Steel Tubing. Babcock & Wilcox, 4 pp, ill, No. TB344. Typical applications of B&W seamless or welded stainless, alloy and carbon steel tubing. Indicates types, shapes and sizes available. (68)

Electroformed Parts. Bart Laboratories Co., Inc., 4 pp, ill. Intricacy, high interior surface finish and close tolerances are claimed to be characteristic of typical parts described. (69)

Welded Steel Tubing. Brainard Steel Co., Tubing Div., 8 pp, ill. Shows facilities for manufacturing welded steel tubing, its applications, fabrication and specifications. (70)

Cemented Carbide Products. Carboloy Co., 60 pp, ill, No. GR-250. Specifications and applications of this company's cemented carbide tools and blanks, both standard and made to order. (71)

Stainless Steel Shapes. G. O. Carlson, Inc., 4 pp, ill. Tank heads, large steel plates, tubing, sheets, forgings and billets, all of stainless steel, are shown as typical of the forms available from this company. (72)

Stainless Pipe. The Carpenter Steel Co., Alloy Tube Div., 5 pp, ill. Compares this company's Schedule 5 stainless pipe with equivalent standard pipe. Indicates advantages and gives technical data. (73)

Thermostatic Bimetal. W. M. Chace Co., 4 pp, ill, No. 1a/10. Properties of thermostatic bimetals and formulae to use in application to temperature responsive devices. (74)

Circular, Rolled and Welded Steel Parts. The Cleveland Welding Co., 8 pp, ill. Describes welded circular and rolled steel parts, their advantages in economic and physical aspects and their applications. (75)

Hard Castings. Coast Metals, Inc., 8 pp, ill. Shows applications of this company's hard castings, comparing their wear resistance with those of other materials used for the same purposes. Includes description of hard facing advantages. (76)

Die Cast Parts. Dollin Corp. Bulletin describes advantages of using this company's facilities for production of small zinc or aluminum precision cast parts. (77)

Metal Parts. Dresser Mfg. Div., 13 pp, ill. Folder describes facilities for production of rings, forgings, weldments and other generally circular shapes of various steels and aluminum. (78)

Metal and Plastics Parts. The Electric Auto-Lite Co., Bay Manufacturing Div, 16 pp, ill. Shows wide variety of custom-made ornamental and functional metal and plastics parts. (79)

Die Cast Parts. The Electric Auto-Lite Co., Die Casting Div., 16 pp, ill, No. G137. Describes facilities for economical manufacture of quality die castings. (80)

Steel Castings. Farrell-Cheek Steel Co., 4 pp, ill, No. 40. Examples of the intricate electric furnace carbon and alloy steel castings produced by this company. (81)

Metal Stampings. Geuder, Paeschke & Frey Co., 12 pp, ill. Detailed description of this firm's metal fabricating, finishing and assembly facilities as a sub-contractor of defense parts. (82)

Investment Cast Parts. Haynes Stellite Co. "Investment Castings" describes features of investment casting process, the economies it enables in the production of precision parts. (83)

Precision Investment Castings. Hitchiner Mfg. Co., Inc. Folder shows numerous case histories demonstrating advantages of precision investment casting of parts over other fabricating methods. (84)

Die Castings. The Hoover Co., Die Castings Div. Describes die casting, gives essential design data, including draft, tolerance and wall thickness and core size requirements. (85)

Iron and Steel Castings. Hunt-Spiller Mfg. Corp. Folder describes extensive facilities for production and finishing of iron and steel castings of any size and quantity. (86)

Beryllium-Copper Springs. Instrument Specialties Co., 12 pp, ill, No. 6. Catalog shows typical properties and applications of beryllium-copper springs and electrical contacts. (87)

Investment Castings. Investment Casting Co., 12 pp, ill. "Investment Casting" describes process for precision casting of intricate close tolerance parts in difficult-to-machine metals and shows advantages. (88)

Stampings. Laminated Shim Co., Stampings Div., 12 pp, ill. Describes facilities for producing good quality stampings to specifications, facts to be considered in ordering stampings, and other data. (89)

Metal Stampings. The Leake Stamping Co., 28 pp, ill. Compares metal stamping with other metal forming methods and shows numerous cases illustrating the advantages of converting to metal stamping. (90)

Gray Iron Castings. Lynchburg Foundry Co., 12 pp, ill. Shows facilities of one of this company's plants engaged in the production of large gray iron castings up to 50 tons. (91)

Magnesium Parts. Magnesium Products of Milwaukee, 4 pp, ill. Briefly describes facilities for designing and producing to order magnesium and aluminum parts. Shows several products. (92)

Welded Assemblies. The R. C. Mahon Co., 1 p, ill. Shows several examples illustrating the capabilities of welding for construction of various assemblies. (93)

Controlled Quality Castings. Meehanite Metal Corp., 8 pp, ill, No. 30. One of a series of bulletins describing the current uses of Meehanite gray iron castings. (94)

Tungsten Carbide Rolls. Metal Carbides Corp., 16 pp, No. CR-50. Manual gives information on use and advantages of tungsten carbide rolls for cold rolling metals. (95)

Powder Metal Parts. Metals Refining Co., Div. of the Glidden Co., 16 pp, ill. Describes fabrication of iron, copper and lead powder metal parts, and discusses limitations and advantages of powder metallurgy. (96)

Precision Cast Products. Microcast Div., Austenal Laboratories, Inc., 9 pp, ill. Shows numerous precision cast parts indicating versatility of process for producing intricate parts. (97)

Precision Investment Castings. Midwest Foundry Co., 4 pp, ill. Typical examples of precision investment cast parts made from stainless steels, their advantages and potentialities. (98)

Aluminum and Zinc Castings. Monarch Aluminum Mfg. Co., folder. File pages on this company's developments in aluminum and zinc casting. Each folder distributed kept up-to-date. (99)

Screw Machine Parts. Mueller Brass Co., 6 pp, ill. Shows brass, bronze and copper custom-made screw machine parts available, and lists other nonferrous products. (100)

Powdered Iron Coil Cores. National Moldite Co., 8 pp, ill. Technical data on elec-

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tronic properties of powdered iron core materials that can be molded to the desired dimensions. Includes range of working frequencies for each. (101)

Seamless Tubing. National Tube Co. Explains time- and cost-cutting fabricating applications of this company's Shelby seamless tubing. (102)

Nonferrous Die Castings. The New Jersey Zinc Co., 28 pp, ill. Applications and principal features of Zamak-3 and Zamak-5 zinc alloy die castings. (103)

Nonferrous Powder Parts. The New Jersey Zinc Co. "Applications and Properties of Nonferrous Powder Parts" includes 14 case histories indicating cost savings in manufacture of brass powder parts. (104)

Seamless Tubing. The Ohio Seamless Tube Co., 12 pp, ill. Shows differences between such tubings as mechanical seamless, aircraft seamless, resistance welded and forged, listing advantages and applications. (105)

Stainless Steel Castings. The Ohio Steel Foundry Co., 4 pp, ill, No. 651-C. Compositions of Fabrite stainless steels for casting and illustrations of numerous corrosion resistant castings. (106)

Copper Tubing. Penn Brass & Copper Co., 6 pp, ill. Features of this company's seamless copper tubing. Includes tables of safe internal working pressures of various tubing sizes. (107)

Spun Shapes. Phoenix Products Co., Metal Spinning Div., 4 pp, ill. Describes Phoenixspun method for spinning spherical and extra deep-drawn contours. (108)

Metal Powder Parts. Plastic Metals Div., 4 pp, ill, No. 567. Describes applications, advantages and limitations of powder metallurgy as used by this firm for custom-making parts. (109)

Powder Metal Parts. Powdered Metal Products Corp. of America. Booklet shows advantages of powder metallurgy in manufacture of such parts as gears, sprockets and valves. (110)

Powdered Metal Parts. Radio Cores, Inc., 4 pp, ill. Describes this company's facilities for production of made-to-order powder metal parts of all types. (111)

Wire Cloth. Reynolds Wire Co., 8 pp, ill, No. 1a/30a. Available materials, styles and sizes of industrial wire cloth, furnished in ferrous and nonferrous materials. (112)

Rigid Metal Sheets. Rigidized Metals Corp., 4 pp, ill, Vol. 1, No. 3. Numerous applications of Rigidized Metals showing their advantages and versatility. (113)

Cast-Weld Construction. Steel Founders' Society of America, ill. Outlines numerous examples of leading foundries' application of cast-weld construction to obtain metals savings and production economies. (114)

Spun Metal Parts. Roland Teiner Co., Inc., ill, No. 51D. Brochure describes this company's facilities for spinning practically any metal or gage required. (115)

Steel Forgings. Titusville Forge Div., Struther Wells Corp., 8 pp, ill. Describes facilities for precision forging of parts regardless of size, metal or alloy. Shows numerous parts produced. (116)

Cold-Headed Parts. Townsend Co., 12 pp, ill, No. TL-64. Describes special cold-headed parts for military applications and gives design tips for those planning to use cold-heading. (117)

Stainless Tubing. Trent Tube Co. *Trentweld Data Bulletin* describes Trentweld stainless steel tubing, machine formed and welded in wide range of sizes. (118)

Formed Tubing. Tube Reducing Corp., 4 pp, ill. Stresses economic advantages of hot-forming complex tubular parts in the plant in which the precision tubing is made. Describes this company's facilities. (119)

Steel Castings. Unitcast Corp., 2 pp, ill. *Modern Foundry Methods* describes advantages in properties, costs and production obtained through use of steel castings in one application. (120)

Flexible Tubing. U. S. Flexible Tubing Co., 16 pp, ill. Description, applications and specifications of this company's flexible metal tubings, bellows for control units, and other metal parts. (121)

Centrifugal Cast Parts. U. S. Pipe and Foundry Co., 12 pp, ill. Describes centrifugal casting process and advantages, and shows three applications improved by this method. (122)

Weldments. The Van Dorn Iron Works Co., 10 pp, ill. Shows this company's facilities for producing weldments and other parts in all sizes, and shows examples of the type of work produced. (123)

Powder Metal Parts. The Wel-Met Co., 12 pp, ill. Design factors, possibilities and application of powder metallurgy. Includes typical designs and powdered metal properties. (124)

Light Metal Shapes. R. D. Werner Co., 4 pp, ill. Explains relative merits of cold roll forming and extruding light metal shapes. Shows company's facilities for both types of fabrication. (125)

Spun Tubing. Wolverine Tube Div., 28 pp, ill. Advantages and numerous applications of this firm's nonferrous Spun End Tube Process. (126)

Coatings • Finishes

Hot Dip Galvanizing. American Hot Dip Galvanizers Assn., Inc., 8 pp, ill. Discusses hot dip galvanizing, its capabilities, and the problems encountered by galvanizers. (127)

Zinc-Plate Bright Dip. The Chemical Corp. Information on Luster-on Utility-25 bright dip for zinc-plated surfaces. Highly resistant to corrosion. (128)

Dry Coloring Resins. Ferro Enamel Corp., folder. Describes colors sold in powder form to be used to coat plastisol and organosol resins. Describes manufacture and available colors. (129)

Protective Coatings. Houghton Laboratories Inc., 3 pp, ill. Applications and uses of "Coradon" and "Coradal" metal conditioning systems for abrasion and chemically resistant coatings. (130)

Wax Finishes. S. C. Johnson & Son, Inc., 16 pp, ill, No. ADV322. Brief descriptions of wax finishes for such materials as rubber, metals, building materials, plastics, and paper and methods for their application. (131)

Protective Coating. Maas & Waldstein Co., No. 117. Technical data on Water Dip No. 33, protective coating for plated metal surfaces said to afford good oxidation protection. (132)

Silicone-Base Paint. Midland Industrial Finishes Co. Brochure shows, by case histories, the effectiveness of Sicon, silicone-base paint, in resisting heat. (133)

Black Oxide Coating. The Mitchell-Bradford Chemical Co., 4 pp, ill, No. MB-3. Six advantages of Black Magic (Type A) Black Oxide coating process for steel and iron. (134)

Coating for Zinc Surfaces. Neilson Chemical Co., No. 48-89. Describes Galvaprep, coating providing good adhesion of paint on galvanized iron, other zinc-coated surfaces. (135)

Lacquer for Molded Polystyrene. New England Lacquer Co., 4 pp, ill. Describes features of new lacquer claimed to successfully coat polystyrene without harm to the plastic or loss of adhesion. (136)

Protective Coating. Nox-Rust Chemical Corp., 4 pp, ill. Features of Nox-Rust 310-AC, thin rust preventing coating said to give temporary protection to metal parts in storage or transit. (137)

Phosphate Coating for Drawing. Parker Rust Proof Co., 7 pp, ill. Theory of phosphate coatings as lubricants for drawing operations, features, successful applications and methods of applying coatings. (138)

Protective Coatings. United Chromium, Inc., 4 pp, ill, No. MC-4. Describes four different groups of Ucilon corrosion resistant coatings giving properties, advantages and case histories. (139)

Corrosion Resistant Coatings. U. S. Stoneware Co., 16 pp, ill, No. 720. Features, chemical resistance and recommended methods for application of Tygon plastic paints for use on concrete and metals. (140)

Methods and Equipment

Heat Treating • Heating

Induction Furnaces. Ajax Engineering Corp. Reprint describes the use of induction furnaces to recover scrap. (141)

Continuous Quenching Tanks. American Gas Furnace Co., 4 pp, ill, No. 820. Specifications of complete line of continuous

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automatic quenching tanks. Shows several factory installations. (142)

Heat Treating Accessories. Brown-Hutchinson Iron Works, 8 pp, ill, No. 10M. Describes specially designed racks, shaker hearths, pusher trays, etc., fabricated to increase furnace capacity. (143)

Furnace Heating Elements. Carborundum Co., Globar Div. Complete data on Globar silicon carbide heating elements, said to be efficient, safe and easy to repair. (144)

Conveyor Furnaces. The Electric Furnace Co. Descriptions of EF chain belt conveyor furnaces for continuous, low cost heat treatment of small and medium size parts. (145)

Electric Tube Furnace. Harper Electric Furnace Corp., 1 p, ill, No. 1148. Describes small, high temperature electric tube furnace for heat treating operations up to 3,000 F. (146)

Metal Baskets. Hoffman Co., 7 pp, ill. Describes this company's metal baskets for use in such processes as heat treating, cleaning, dipping and plating. Price list included. (147)

Pot Furnaces. The A. F. Holden Co., 19 pp, ill. Principles, features and advantages of this company's four types of pot furnaces for heat treating at temperatures up to 2350 F. (148)

Heat Treating Fixtures. Hoskins Mfg. Co. Catalog shows various heat treating fixtures, baskets, etc., made from heat resistant alloys. (149)

Heat Treating Furnaces. Ipsen Industries, Inc., 6 pp, ill. Diagrammatic description of operating principle of Ipsen Series "T" Heat Treating Unit. Includes specifications and applications. (150)

Combustion Equipment. C. M. Kemp Mfg. Co. "Kemp Combustion Equipment" describes features and specifications of this firm's line of burners for such uses as metal melting and heat treating. (151)

Induction Heating. The Ohio Crankshaft Co. Describes plant survey and possible applications to which induction heating might be put for greater production economy. (152)

High Temperature Equipment. Rolock, Inc. No. B-8. Catalog gives data on fabricated heat and corrosion resistant alloys for heat treating uses. (153)

Heat Treating Furnaces. Standard American Engineering Co., 6 pp, ill. Principle of Radivection gas fired furnaces, indicating advantages in more uniform, faster heating for heat treating purposes. (154)

Heat Treating Equipment. Sunbeam Corp., Sunbeam Stewart Industrial Furnace Div., 4 pp, ill, Vol. 10, No. 6. *Metal Minutes* shows various applications of this company's equipment in user's plants. (155)

Heat Treating Equipment. Surface Combustion Corp., 4 pp, ill, No. SC-152. Features of this company's heat treating equipment that can be used to heat treat aircraft metals and parts. (156)

Gear-Hardening Machine. Westinghouse Electric Corp., No. B-5259. Describes operation of radio frequency gear-hardening machine for hardening gears and shafts. (157)

Electric Immersion Heaters. Edwin L. Wiegand Co., 48 pp. Catalog shows complete line of Chromalox electric heaters, giving applications and specifications. (158)

Cleaning • Finishing

Cleaning and Finishing Media. Almco Div., Queens Stove Works, Inc., 10 pp, ill. Features and applications of Supersheen abrasive chips and compounds for barrel finishing and cleaning. Also data on finishing machines. (159)

Belt Grinders and Finishers. Behr-Manning. Bulletin describes advantages of belt finishing and grinding, shows this company's equipment, and suggests methods for cost cutting. (160)

Wet-Blasting Units. The Cro-Plate Co., 4 pp, ill. Describes new line of wet-blasting units for high production deburring, descaling, stock removal and general finishing. (161)

Metal Cleaner. The Diversey Corp., 4 pp, ill, No. 49A. Advantages of Diversey No. 909 heavy duty soak tank cleaner, said to be noncaustic, yet exceptionally powerful. (162)

Finishing Equipment. The Murray-Way Corp. Catalog describes full line of this firm's automatic polishing, buffing and grinding equipment. (163)

Metal Cleaner. Niagara Alkali Co. Pamphlet gives properties of Nialk Trichlorethylene, high quality metal cleaning and degreasing agent. (164)

Metal Cleaning. Northwest Chemical Co., 2 pp. Describes "Lo-Hi" two-tank process for the preparation of metals for plating and vitreous enameling. (165)

Cleaning Aircraft Metals. Oakite Products, Inc., 48 pp, ill, No. F5562R2. Detailed descriptions of methods used for cleaning aluminum, magnesium and other metals for aircraft. (166)

Vapor Degreasers. Phillips Mfg. Co., 12 pp, ill. Describes vapor degreasing process, its advantages and applications, and shows this company's degreasing units. (167)

Industrial Brushes. Pittsburgh Plate Glass Co., Brush Div., Dept. W-4, 3221 Frederick Ave., Baltimore. Md. Case histories indicate economies available to users of Pittsburgh brushes. Request on company letterhead direct from this company.

Tumbling Barrels. Tumb-L-Matic, Inc., 2 pp, ill, No. XL-48. Features and specifications of Lupomatic wet process tumbling barrels for deburring and cutting down metal parts. (168)

Hard Chromium Plating Unit. Ward Leonard Electric Co., 4 pp, ill. Features of Model A-20 Chromaster industrial hard chromium plating unit, description of process and Chromasol solution. (169)

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Welding • Joining

Welding Equipment. Air Reduction Sales Co., ill, No. ADC717. Catalog describes Aircomatic manual and automatic welding equipment and the wires for use with either. (170)

Welding Alloys and Fluxes. All-State Welding Alloys Co., Inc., 32 pp, ill. Helpful data for ordering and using this company's alloys and fluxes for brazing, welding, soldering, cutting and tinning. (171)

Aluminum Fasteners. Aluminum Co. of America, 8 pp, ill, No. AD-244. Descriptions and specifications of this firm's standard and miscellaneous fasteners and screw machine products. (172)

Brazing Alloys. The American Platinum Works, 46 pp, ill. Handy-sized manual gives detailed description of the brazing process, the alloys used, design of joints and other considerations for successful joining. (173)

Stainless Fasteners Specifications. Anti-Corrosive Metal Products Co., Inc., slide indicator. Identifies the type of fastener specified by each A-N number pertaining to stainless fasteners. Refers user to this company's catalog for more data. (174)

Welding Cost Calculator. Champion Rivet Co., slide indicator. Shows the costs for welding materials using various types of fillets and joints and estimates the various factors effecting the costs. (175)

Welding Positioners. Cullen-Friestadt Co., ill. Catalog shows line of hand- or power-operated welding positioners with capacities up to 30,000 lb. (176)

Wing Nuts. Gries Reproducer Corp., 4 pp, ill. Dimensions, sizes and other data on zinc die cast nuts said to be rust proof and corrosion resistant. (177)

Silver Brazing Alloys. Handy & Harman, 24 pp, ill, No. 20. Information on Easy-Flo and Sil-Fos low temperature silver brazing alloys, and valuable data on brazing methods. (178)

Fasteners. H. M. Harper Co., 8 pp, ill, Vol. 16, No. 4. *Bolt News* describes interesting applications of this company's corrosion resistant fasteners and discusses various products. (179)

Cold Headed Fasteners. John Hassall, Inc., 34 pp, ill, No. 60. Explains cost savings available through use of cold headed fasteners. Shows complete line of nails, rivets, screws and other fasteners. (180)

Welding Nickel Alloy. Illium Corp., 4 pp, No. 105B. Instructions for metallic arc and oxyacetylene gas welding of Illium, nickel-base, corrosion resistant alloy. (181)

Aluminum Fasteners. The Jacques Co., 8 pp, ill, No. 50A. Price list and specifications of this company's line of aluminum fasteners. (182)

Induction Heating for Brazing. Lepel High Frequency Laboratories, Inc., 8 pp, ill. Details on induction heating units for accelerated brazing of parts. (183)

Rapid Arc Welding. The Lincoln Electric Co., 48 pp, ill, No. 444. Manual discusses method of arc welding at high speeds

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and lower costs. Describes procedures for making various types of joints, recommends electrodes. (184)

Designing for Welding. Linde Air Products Co., 20 pp, ill, No. F7811. Reprints of articles stressing the economies of good welding design. Includes summary of standard welding symbols. (185)

Welding Accessories. Metal & Thermit Corp., 31 pp, ill, No. E-138. Descriptions and specifications of complete line of welding accessories, including electrode holders, safety equipment, electrical equipment and special tools. (186)

Adhesives, Coatings and Sealers. Minnesota Mining and Mfg. Co., 8 pp, ill, No. Z-SCPD. Illustrates typical applications of 3M adhesives, coatings and sealers to wide variety of uses. Includes table of properties. (187)

Fastener. New Process Screw Co. Bulletin describes Twin-fast screws for rapid fastening of wood to metals, plastics or other woods. (188)

Gold and Platinum Solders. The J. M. Ney Co., 1 p. Data sheet gives melting ranges and colors of this company's gold and platinum solders for electronic tube applications. (189)

Self-Locking Fasteners. The Palnut Co., 1 p, ill. Describes self-locking machine screw Palnuts, coil tube fasteners, shield can fasteners and acorn Palnuts. (190)

Self-Locking Set Screw. Set Screw & Mfg. Co., demonstrator. Shows, by means of cardboard parts, locking action of this company's Zip-Grip self-locking set screws. (191)

Carbon Arc Welding. Speer Carbon Co., 8 pp, ill. Advantages of carbon arc welding for fabricating and repairing alloy and nonferrous metals. (192)

Special Fasteners. Tinnerman Products, Inc., No. 500. Catalog gives specification for all of this firm's aircraft fasteners produced under Mil-N-3337 specifications, applications and describes development. (193)

Forming • Casting • Molding • Machining

Shell-Molding. The Borden Co., Chemical Div., 8 pp, ill. Describes the shell-molding process, its advantages, the equipment used and gives historical background. (194)

Machining Equipment. The Cincinnati Milling Machine Co., 48 pp, ill, No. M-1712. Features and specifications of this company's automatic flame hardening machines, grinding machines and milling machines. (195)

Plastics Molding Equipment. Improved Paper Machinery Corp., 4 pp, ill. Features and advantages of Impco injection-compression, plunger, transfer and injection molding machines for plastics. (196)

Grinding and Abrasive Equipment. The Norton Co., 4 pp, ill. Short description of this company's literature, films and courses on grinding and the selection and care of abrasive products. (197)

Grinding Equipment for Forming. Pratt & Whitney Div., 8 pp, ill, No. 543. Features, advantages, accessories, applications and specifications of attachment for grinding parts to form using formed grinding wheels. (198)

Plastics Fabrication. F. J. Stokes Machine Co., 4 pp, ill, Vol. 1, No. 1. *Stokes Plastics Review* describes new plastics fabricating equipment, its features, advantages and application. (199)

Punch Presses. Wales-Strippit Corp., 8 pp, ill, No. TC. Describes this company's new twin column presses and their use in blanking, forming, bending, drawing, notching and punching operations. (200)

Aluminum Extrusion Presses. Watson-Stillman, ill, No. 340-A. Describes this company's light metals extrusion presses of 500- to 5000-ton capacities, their features and advantages. (201)

Adjustable Perforating Dies. S. B. Whistler & Sons, Inc. Catalog describes this company's line of adjustable perforating dies for punching holes in sheet metals. Includes prices and applications. (202)

Tube Mills. The Yoder Co., 65 pp, ill. Pros and cons of operating a tube mill, plus detailed information on the process. Also technical data on standard and other equipment. (203)

Inspection • Testing • Control

Contour Measuring Projector. Bausch & Lomb Optical Co., No. D-27. Specifications and features of contour measuring projector claimed to enable very accurate measurements of parts. (204)

Metallograph. Bausch & Lomb Optical Co., 20 pp, ill, No. E-232. Features of Balphot metallograph for microscopic examination of metallographic specimens. (205)

Specimen Grinders. Buehler Ltd., 6 pp. Describes belt and wheel type grinders and surfacers for wet or dry grinding of metallographic specimens. (206)

Thermocouples. Charles Engelhard, Inc., No. 330-D. Shows features of full line of this company's noble metal thermocouples. (207)

Pocket Thickness Gage. Ferro Enamel Corp. Describes pocket-size thickness gage said to give good accuracy for measuring nonmagnetic coatings on ferrous surfaces. (208)

Temperature Control. Claud S. Gordon Co., 4 pp, ill. Features, advantages and application data on Xactline fully automatic temperature controls for electric ovens, furnaces, kilns and molding machines. (209)

Metallurgical Laboratory Equipment. Harshaw Chemical Co., Harshaw Scientific Div., 12 pp, ill, No. D2637. Catalog describes and gives specifications of this company's available metallurgical laboratory equipment. (210)

Temperature Control. Illinois Testing Laboratories, Inc. Describes Alnor Dewpointer for checking simply and accurately the dew point of gases degenerated for heat treating. (211)

Identification of Some Metals. The International Nickel Co., 48 pp, ill. Procedures for spot testing of some metals and alloys for identification purposes. (212)

Universal Testing Machines. National Forge & Ordnance Co., Testing Machine Div., No. 501. Specifications, capacities and operating principle of table model universal testing machines. (213)

Temperature Controls. The Pyrometer Instrument Co., No. 150. Catalog shows Pyro Immersion Pyrometer, accurate instrument for nonferrous foundry temperature control. (214)

Hardness Testing Machine. Steel City Testing Machines, Inc., 2 pp, ill, No. H 249. Specifications, operating instructions and description of Model UK-300-H manually operated Brinell testing machines. (215)

Pyrometer Wire Color Codes. Thermo Electric Co., Inc. Handy chart gives pyrometer color codes, calibration symbols and parts meeting ISA, military and aeronautical specifications. (216)

Package Testing. United States Testing Co., Inc., 8 pp, ill. Describes methods for testing packages designed for products up to 1000 lb for vibration and impact. Includes prices. (217)

Hardness Testers. Wilson Mechanical Instruments Co., 12 pp, ill, No. DH-114. Descriptions and specifications of several Tukon hardness testers. Includes discussion of hardness testing and applications. (218)

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General

Heat Exchangers. Corning Glass Works, 8 pp, ill, No. PE-8. Includes charts simplifying the calculation of heat transfer requirements and data on newly designed cascade-type heat exchanger. (219)

Vacuum Pump. Kinney Mfg. Co., No. V51-A. Features, specifications and price information on CVM3153 Midget Vacuum Pump. (220)

Chain and Belt Conveyors. Michigan Steel Casting Co., 8 pp, ill, No. 1-B. Shows Misco rivetless chain conveyors and Woodman belt conveyors for high temperatures. (221)

Vacuum Unit. Radio Corporation of America, Scientific Instruments Section, 4 pp, ill. Features, applications, description and specifications of vacuum unit for vacuum deposition of metals and laboratory work. (222)

Foundry Blowers. The Spencer Turbine Co., No. 112. Bulletin describes use of Spencer Turbos as blowers for foundries, giving blower features and advantages. (223)